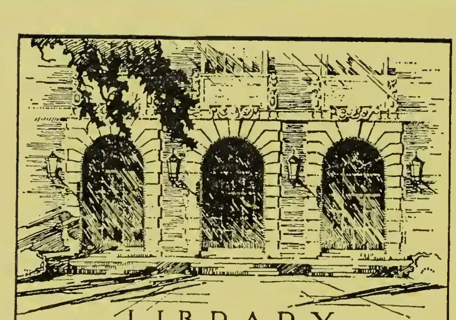

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BULLETIN OF THE
UNIVERSITY OF MISSOURI.

VOL. III. AUGUST, 1902.—03 NO. 8.

SCHOOL OF ENGINEERING.

Historical Statement. The Legislative Act establishing the University was approved 11 February, 1839. The University was located at Columbia, which is now a beautiful city of 6,000 inhabitants, midway between St. Louis and Kansas City, on the Wabash, and Missouri, Kansas and Texas Railroads. The cornerstone of the main building was laid 4 July, 1840, which is generally accepted as foundation day. The School of Mines and Metallurgy, a Department of the University, was located at Rolla, Missouri.

Resources. The buildings, grounds, books, and other equipment of the University, are valued at $1,300,000, not including the campus or grounds for Agriculture, Horticulture and Botany. The endowment, bearing interest at five or six per cent, is $1,236,000. The income from the United States Government (Hatch and Morrill Acts) is $38,150 a year. The Legislature makes appropriations biennially. There are 47,000 acres of unsold land. The Supreme Court of Missouri has upheld a Collateral Inheritance Tax giving us about $120,000 a year. The income of the whole University, from all sources and for all Departments, in each of the calendar years 1901 and 1902, is about $420,000.

Tuition Free. It is one of the foremost purposes of this University to place higher education within the reach of all who are intellectually and morally qualified to receive it. Therefore, tuition is free in all Departments—Graduate, Engineering, Academic, Department of Education, Medicine, College of Agriculture, Mines and Metallurgy. In these Departments the only charges are a library fee of $5 a year and small laboratory deposits covering the cost of materials used by the students.

Published by the University of Missouri. Issued monthly. Application has been made for entry of this publication as second-class matter.

Expenses. The expenses for room, board, books, and fees vary from $130 to $200 a year. For Engineering students who board in our club houses these expenses need not exceed $130. For those who get the best board in private families the expenses mentioned above need not exceed $200 a year. The fees in some colleges and universities will bear all expenses here.

Buildings. Engineering, Mechanic Arts, Power Plant, Observatory, Academic Hall, Chemical Laboratory, Biology and Geology, Agricultural Hall, Hospital, Law, Medical, Dairy, Stock Judging, Veterinary, Horticulture. Two Dormitories for Men, one Dormitory for Women. The School of Mines at Rolla has seven buildings.

A new Engineering Laboratory will be ready for occupancy at the opening of the University in September. It is a two-story brick structure connected with the present Engineering Building, and will furnish approximately the same floor space. The first floor is for the heavy machinery of the hydraulic, dynamo and steam engineering laboratories. The second floor contains laboratories for cement, electrical and mechanical testing, standardizing, gas analysis, etc.

Libraries. There is a General Library, accessible to all students, and four special Engineering Libraries, containing the best technical books and magazines of America and Europe, for the use of Engineering students. The General and Departmental Libraries contain about 50,000 volumes. Photographs, blueprints, and lantern slides of engineering structures are available. In the present year $28,000 will be spent in enlarging the libraries.

Laboratories and Shops. The Engineering Laboratories, together with the extensive power, heating, lighting, ventilating, pumping, and refrigerating plants of the University contain representative equipment of modern Engineering practice in Civil, Electrical, Mechanical, Hydraulic, Sanitary, and Steam Engineering. The Shops, of modern construction, contain equipment covering the entire range of wood and metal work. The general and departmental draughting rooms are equipped with the apparatus necessary for first-class draughting work. The new Engineering Laboratory is being equipped throughout with new machinery and apparatus at a cost of $23,000.

Courses and Degrees. All the field, class room, draughting room, and laboratory work is done under the direct supervision of the heads of the various Engineering departments, who have had practical experience in their special lines. Instruction is given by lectures and recitations, supplemented by field, draughting, and laboratory work, as follows:

In Civil Engineering. Attention is given to the study of Surveying, Railroad Engineering, Geodesy, Bridge Building, Municipal Engineering, Highways, Masonry and Foundations, and Hydraulics.

In Electrical Engineering. The course prepares young men for electrical designing, manufacturing and contracting, and for the complete installation of power and lighting plants. Especial attention is paid to alternating currents, the design and construction of electrical machinery, and long distance electrical transmission of power.

In Mechanical Engineering. Stress is laid upon the theory of prime movers; the theory, design, and construction of machines, engines, and boilers; the installation and economical running of power; heating, and ventilating plants; the theory and strength of cast iron and riveted construction.

In Sanitary Engineering. The course covers modern methods of constructing buildings, ventilation, lighting, heating, plumbing, sewage and garbage disposal, water supply, and Municipal Engineering in general.

Chemical Engineering. In view of the large development in Chemical Engineering, a course is offered which is intended to provide instruction in Engineering together with specialization in Chemistry, to supply the demand for trained engineers in industrial works of this character.

Degrees. These courses are four years each and lead to the Degrees of Bachelor of Science in Civil Engineering, in Electrical Engineering, in Mechanical Engineering, in Sanitary Engineering, and in Chemical Engineering. Graduate courses are offered leading to the Degrees of Civil Engineer, Electrical Engineer, Mechanical Engineer, and Hydraulic Engineer.

Requirements for Admission. The following are the requirements for admission to the Freshman Class:

1. English, three years work.
2. Mathematics—Algebra, and Plane Geometry, three years work.
3. Six units to be selected from the following list of subjects: Solid Geometry and Plane Trigonometry, History, Latin, Greek, Ger-

man, French, Spanish, Physics, Chemistry, Biology, Zoölogy, Botany, Physiography, Physiology, Drawing, Shop. The minimum allowed in any one of these subjects is one unit. The maximum varies from one to four units. A unit is equivalent to one year's work in a good High School.

Other Departments. Graduate Department, College, Department of Education, School of Agriculture, School of Mechanic Arts, Law Department, Medical Department, School of Military Science and Tactics, School of Mines and Metallurgy. These with the School of Engineering constitute the University of Missouri.

Enrollment. The students of the University come from almost every county in Missouri. Forty-eight states and foreign countries were represented in the 1,671 students enrolled last year.

Religious Influence. Almost all denominations are represented in Columbia. Few towns of its size in the West can be compared with it in the excellence of its churches. The University has a zealous chapter of the Young Men's Christian Association. There is a student prayer meeting at eight o'clock every morning. Prayers by officers of the University also are held every morning. Attendance, however, upon religious exercises is voluntary.

Athletic Sports. Our students have teams for football, baseball, basketball, track athletics, and lawn tennis. There is a good Gymnasium and the Athletic Field is one of the best in America.

Opportunities in Missouri. Missouri is in wealth and population the fifth State in the Union. Its natural resources, which are vast, have been imperfectly developed. It is a land of opportunity for enterprising young men. The best introduction to any State is through its University. Our students represent the entire State. All members of the graduating classes for the last four years, have accepted positions immediately on graduation.

Catalogue. For catalogue giving detailed information concerning the University, address the Registrar, Mr. Irvin Switzler, Columbia, Missouri.

H. J. WATERS, Dean.

July 26, 1902.

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BULLETIN OF THE UNIVERSITY OF MISSOURI

. IV. AUGUST, 1903-04 NO. 8

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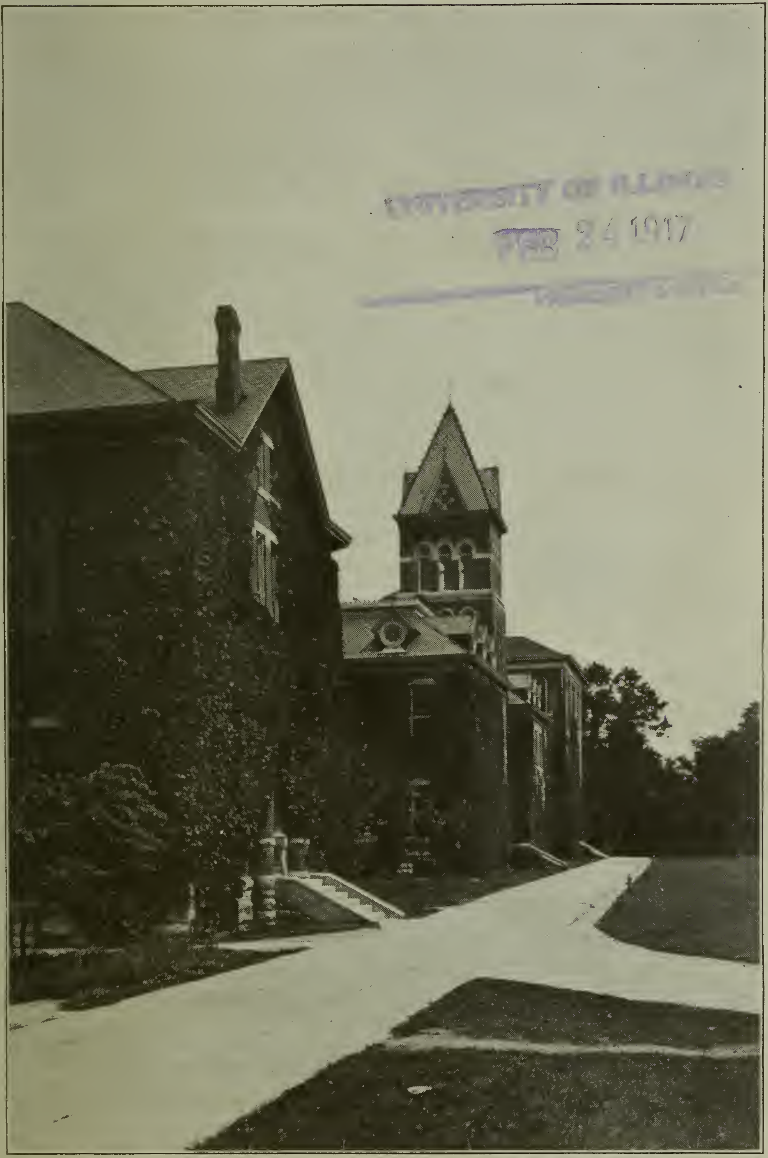
SCHOOL OF ENGINEERING

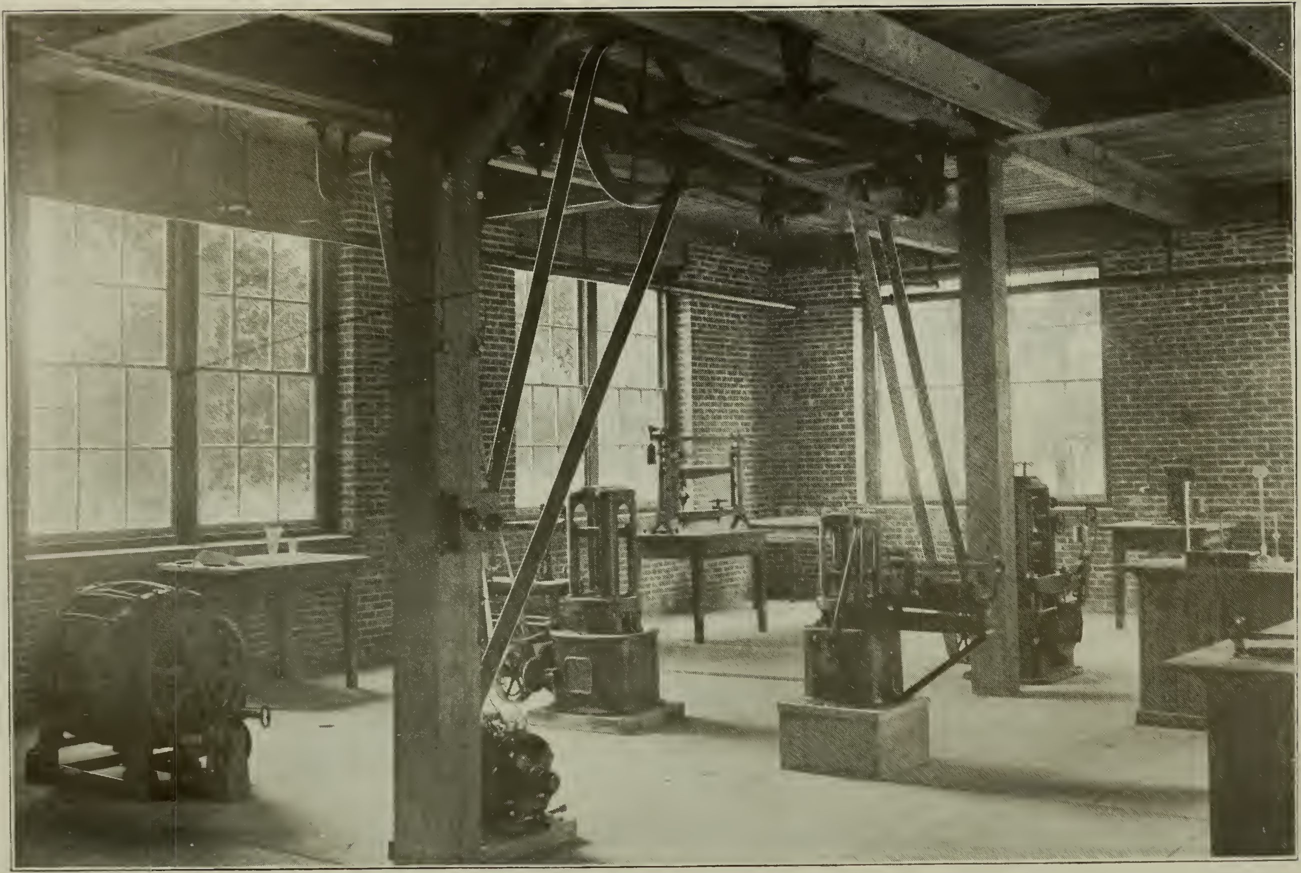


UNIVERSITY OF ILLINOIS
FEB 24 1917

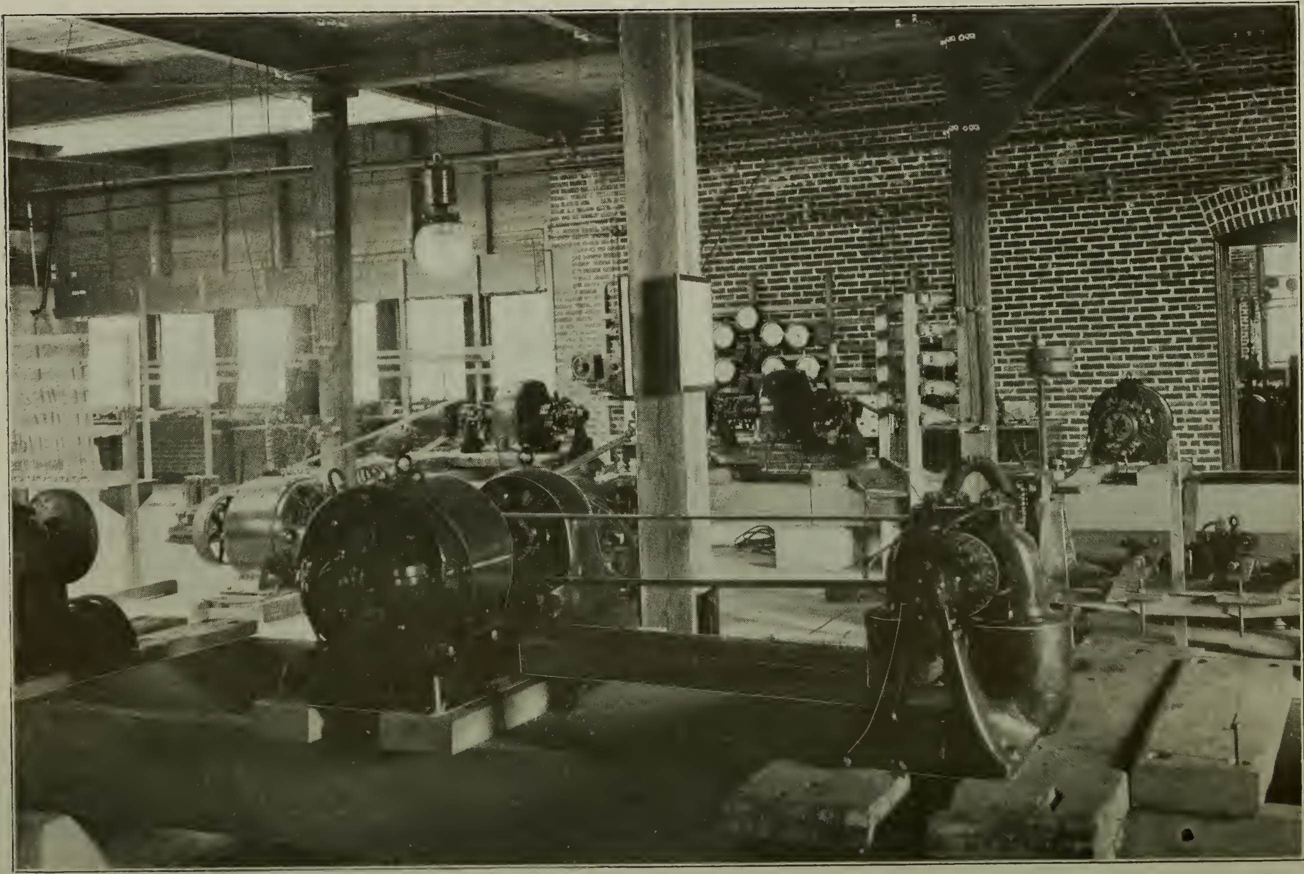
Mechanic Arts Engineering

THE WEST SIDE OF THE CAMPUS—LOOKING NORTH

ished by the University of Missouri. Issued monthly. Entered April 12, 1902, at Columbia, Missouri, as second-class matter, under act of Congress of July 16, 1894.



CIVIL ENGINEERING LABORATORY



ELECTRICAL ENGINEERING LABORATORY

CORNER OF ONE OF THE DRAWING ROOMS

Observatory
(Geoditic Surveying)

CHEMISTRY BUILDING

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BULLETIN OF THE
UNIVERSITY OF MISSOURI.

VOL. IV. AUGUST, 1903. NO. 8.

SCHOOL OF ENGINEERING.

Historical Statement. The University of Missouri was founded in 1840. The Department of Education was founded in 1867; that of Law, in 1872; and that of Medicine in 1873. The College of Agriculture and Mechanic Arts was established at Columbia, and the School of Mines at Rolla, in 1870. In 1877, a chair of Civil Engineering was established in the College of Agriculture and Mechanic Arts, and, later were added chairs of Electrical and Mechanical Engineering. Columbia, a beautiful city of 7,000 inhabitants, about midway between St. Louis and Kansas City, is on the Wabash and the Missouri, Kansas, and Texas Railroads.

Resources. Our buildings, grounds, books, and other equipment, are valued at more than $1,550,000, not including the campus or the grounds for Botany, Horticulture, and Agriculture. The endowment (interest at 5 or 6 per cent) is $1,236,000. The income from the United States Government (Hatch and Morrill Acts) is $38,150 a year. Moreover, the Legislature makes appropriations biennially. There is some income from fees for libraries and laboratories. There are 47,427 acres of unsold land. A State Collateral Inheritance Tax yields about $120,000 a year. The income of the whole University, from all sources and for all departments, in each of the calendar years 1901 and 1902, was about $425,000. It will not be less in 1903-4.

Expenses. Free Tuition. Tuition is free in all Departments—Graduate, Academic, Department of Education, Medicine, College of Agriculture, Engineering, School of Mines. In all these Departments, except Law and Medicine, the only charges are a library fee of $5 a session and small laboratory deposits covering the cost of materials used by the students. In Medicine the only charge is a library fee of $10 a year and small laboratory deposits. In Law, the only charge is a library fee of $10 a year. The expenses for room, board, books, and fees vary. For Engineering students who board in our club houses these expen-

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ses need not exceed $140, nor more than $200 a year for those who board in private families. The fees in some Colleges and Universities will bear all expenses here.

Buildings. Engineering Hall, Engineering Laboratory, Powerhouse, Mechanic Arts Hall, Observatory, Chemical Laboratory, Laboratory of Geology and Zoology, Academic Hall, Agricultural Hall, Dairy Laboratory, Live Stock Laboratory, Agricultural Barns, Laboratory of Horticulture Entomology and Botany, Greenhouse, Law Building, Medical Laboratory, Hospital, three Dormitories, President's House. Our School of Mines has seven buildings. Next year we may expend about $200,000 for new buildings, including a separate Laboratory for Physics, a Gymnasium, and a Hospital for Animals.

Laboratories. There are at Columbia many laboratories of science and technology, seven rooms for drawing and designing, and several shops. The School of Mines has several laboratories and drawing rooms and shops. Of the $252,000 expended for new buildings in 1902, $154,000 went for laboratory buildings. Nearly $60,000 more were spent for their better equipment with apparatus. Thus about $214,000 were invested last year in better facilities for our laboratory work.

Libraries. We have a library for general readers and several department libraries for professors and advanced students. These libraries contain nearly 60,000 bound volumes. Moreover, the collections of the State Historical Society, 21,000 volumes, in Academic Hall, are accessible to our students.

Faculties. Our faculties contain, all told, more than 120 teachers. Twelve Professors, Assistant Professors, and Instructors give their entire time to mechanical drawing, shop work, civil, electrical, and mechanical engineering.

Enrollment. The students of the University come from almost every county in Missouri. Fifty-six states, territories, and foreign countries were represented here during the session of 1902-1903 by 1591 students. The enrollment at Columbia in Engineering has increased in five years from 66 to 230.

Requirements for Entrance. A good high school education, or its equivalent, and evidence of good character are demanded for admission to any department.

Religious Influences. Almost all denominations are represented at Columbia. The city is notable for its churches. The University has a zealous chapter of the Young Men's Christian Association, and one of the Young Women's Christian Association. There is a students' prayer meeting every week. Prayers by officers of the University also are held every morning. Attendance upon religious exercises is voluntary. A large number of students voluntarily attend courses of Bible study.

Debates and Athletic Sports.

Our students have teams for foot ball, base ball, basket ball, track athletics, and lawn tennis. There is a gymnasium for men and another for women. The athletic field and the golf links are excellent. Much success has attended our contestants in inter-collegiate debates. There are fourteen literary and scientific societies among the students, including a flourishing "Engineers' Club."

Courses and Degrees.

Instruction is given in Civil, Electrical, Mechanical, Sanitary, Hydraulic, and Chemical Engineering. The degrees of Bachelor of Science in Civil, Electrical, Mechanical, and Chemical Engineering, and the graduate degrees of Civil, Electrical, and Mechanical Engineer are conferred.

Civil Engineering.

Three courses are given: one in Civil Engineering, leading to broad, general training; a course in Sanitary Engineering, with less attention to structural and railway work and more to sanitary subjects; a course in Hydraulic Engineering, giving special attention to hydraulic and irrigation problems. The surveying instruments are new. They include 13 transits, 9 levels, 2 plane tables, 4 compasses, sextant, tapes, and small instruments, and for precise work, an 8-inch Fauth Theodolite, Brandis triangulation transit, precise level, base apparatus, etc. The laboratory has a brick abrasion machine, 2 torsion machines, 3 testing machines for tension and compression, Olsen and Fairbanks cement machines, briquette press and mixer, boilers for steam tests, Vicat and Gilmore needles, etc. For office work there are rolling and polar planimeters, a pantagraph, topographical protractors, stadia charts and slide rule, Thatcher calculating instrument, beam compass, etc. About 500 drawings of recent bridges, presented by Mr. T. J. Wilkerson (class of 1890) of Pittsburg, and a set of 130 drawings, carefully arranged, indexed, and presented by Mr. J. A. L. Waddell, illustrating recent practice in bridge design, are available for instruction.

Electrical Engineering.

This course is arranged to give fundamental training in Electrical Engineering, with as much as possible of the practical applications. Thoroughness in English, Chemistry, Physics, and Mathematics is insisted upon. The strictly technical studies include Electrical Measurements, Electrical Machinery, Alternating Currents, Electrical Design, Transmission and Distribution, besides Surveying and studies in Mechanical Engineering. A branch section of the American Institute of Electrical Engineers has been established and discussion of current literature is a feature of the training. The equipment consists of some 30 dynamos for laboratory work in direct and alternating currents, including two double-current generators, which are used for a great variety of tests; of apparatus for standardizing instruments, and for electrical testing; and of storage batteries, ammeters, voltmeters, wattmeters, tachometers, resistances, lamp banks, etc.

Mechanical Engineering. This course prepares for any of the branches of Mechanical Engineering, giving a thorough foundation in the general principles and developing several important divisions. The study of engineering materials is applied to the designing of structures and machinery. The theory of machines is taught as well as the practical operation, in connection with the development, transference, and use of power. These principles are tested in the laboratory, which is equipped with various types of compound and simple engines, a two-stage-duplex air compressor, compound duplex steam pump, steam pumps, power pumps, pulsometers, injectors, condensers, steam turbine, gas, oil, and hot-air engines, water wheels, and the necessary meters, gauges, weirs, and tanks. The work in the laboratory is done by the students, who make all arrangements and tests of apparatus. The problems in laboratory and class room are taken from practice.

Mechanics. A department has been established for work in theoretical and applied Mechanics, formerly given by the Professor of Mechanical Engineering.

Drawing. Instruction is given in Mechanical Drawing, Descriptive Geometry, Lettering, and Machine Drawing. All engineering students are taught practical draughting room methods as well as the making of accurate and comprehensive drawings.

Shops. The joinery, forge, pattern, and machine shops contain 1600 square feet of floor space each, and accommodate sections of twenty-four students. The machine shop is equipped with engine-lathes, shapers, power saws, drill presses, planers, grinder, milling and screw machines. The underlying principles of production and erection are taught and also the limitations of materials and machines.

Other Departments. All courses in the University at Columbia, including the Academic and other departments, are open to engineering students, with the consent of the Dean.

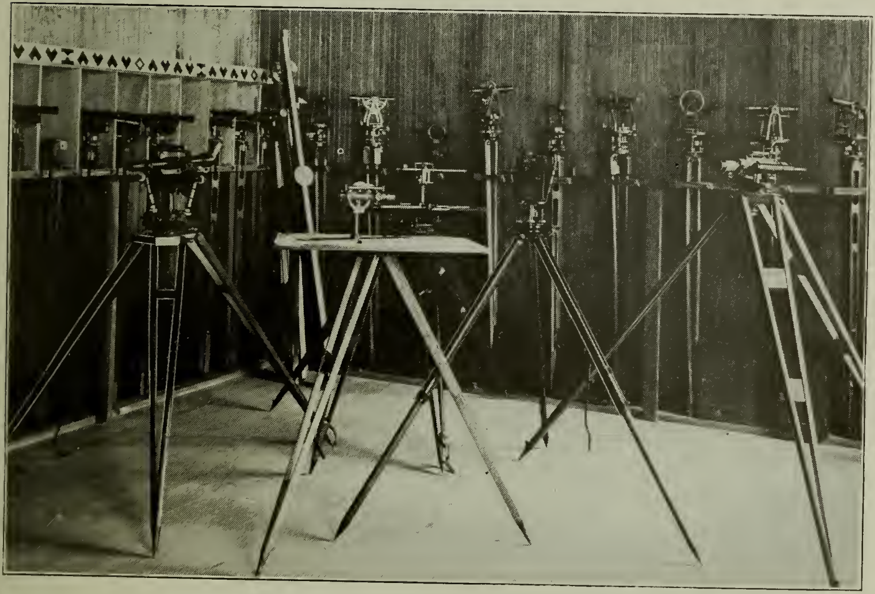
Opportunities in Missouri. Missouri contains 69,415 square miles—nearly 3,000 more than New England. The population is 3,106,665. While the development of its resources has scarcely begun, Missouri is the fifth state in the Union in population, in wealth, and in agriculture, and the seventh in manufactures. For mining it is justly famous. It is a land of opportunity for enterprising young men. The best introduction to any state is through its university.

Catalogue. If this circular interests you, write for a catalogue of the whole University or of any Department. If, thinking seriously of attending this University, you wish to see plates illustrating its buildings, these too will be sent you. Address the Registrar, Mr. Irvin Switzler, Columbia, Missouri.

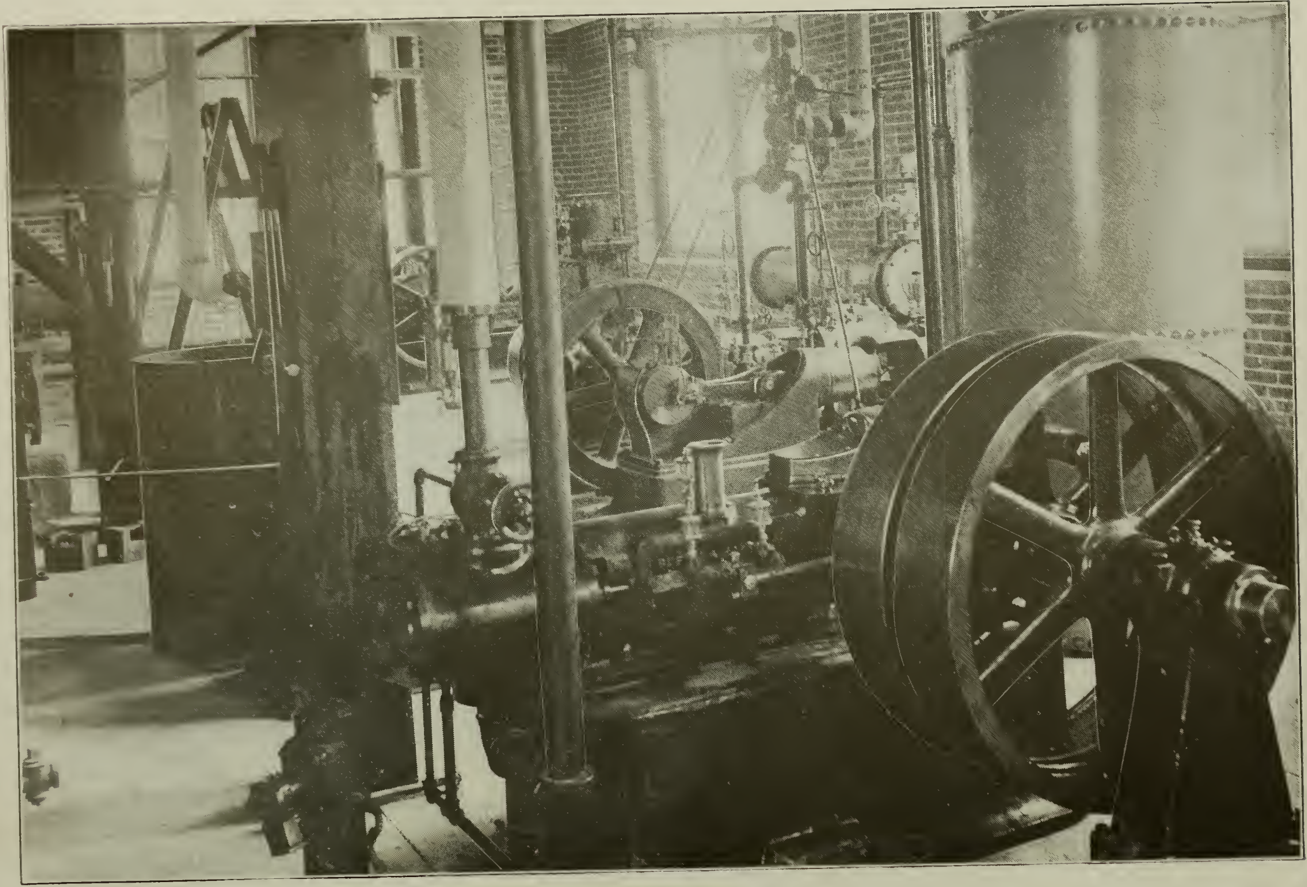
F. B. MUMFORD,
Acting Dean.

1 August, 1903.

MECHANIC ARTS BUILDING AND POWER HOUSE

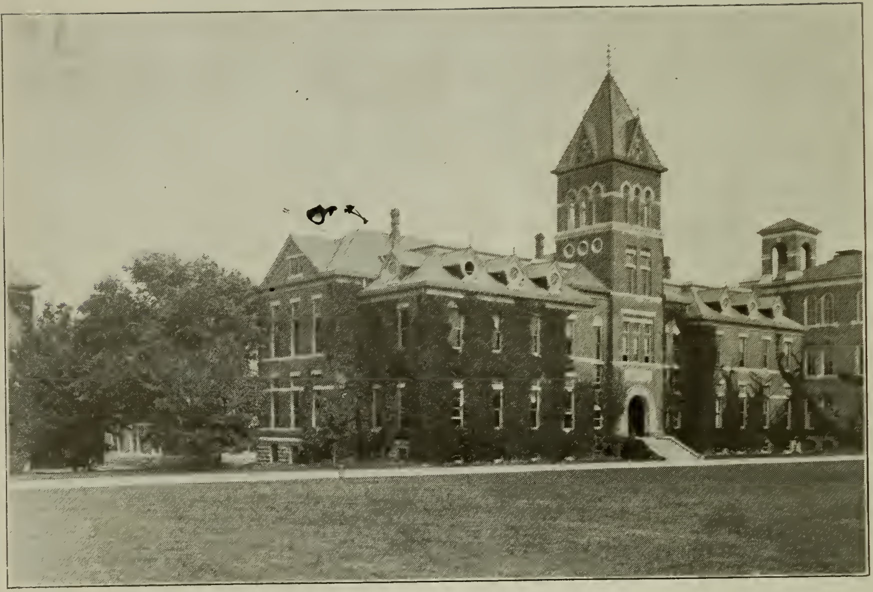


SURVEYING INSTRUMENTS



MECHANICAL ENGINEERING LABORATORY

MACHINE SHOP



ENGINEERING HALL

ENGINEERING LABORATORY

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BULLETIN

OF THE

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VOL. V. AUGUST, 1904. -05- NO. 8.

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Resources. Our buildings, grounds, books and other equipment, are valued at more than $1,600,000, not including the campus, or the grounds for Botany, Horticulture, and Agriculture. The endowment (interest at 5 or 6 per cent) is $1,236,000. The income from the United States Government (Hatch and Morrill Acts) is about $38,150 a year. The Legislature makes appropriations biennially. There is some income from fees for the libraries and laboratories. There are 47,427 acres of unsold land. A State Collateral Inheritance Tax gives us about $120,000 a year. The income of the whole University, from all sources and for all departments, has been for some time from $400,000 to $430,000 a year.

Free Tuition. Expenses. Tuition is free in all Departments—Graduate, Academic, Teachers College, Medicine, Law, College of Agriculture, Engineering, School of Mines. In all these Departments, except Law and Medicine, the only charges are a library fee of $5.00 a session and small laboratory deposits covering the cost of materials used by the students. In Medicine the only charge is a library fee of $10 a year and small laboratory deposits. In Law the only charge is a library fee of $10.

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Buildings.

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Laboratories.

There are at Columbia many laboratories of science and technology, rooms for drawing and designing, and several shops. The School of Mines has several laboratories and drawing rooms and shops. Of the $252,000 expended for new buildings in 1902, $154,000 went for laboratory buildings. Nearly $60,000 more were spent for their better equipment. Thus about $214,000 were invested that year in better facilities for laboratory work, and other sums in 1903.

Libraries.

We have a library for general readers and several department libraries for professors and advanced students. These libraries contain 65,000 bound volumes and 30,000 pamphlets. Moreover, the collections of the State Historical Society, 23,000 entries, in Academic Hall, are accessible to our students.

Faculties.
Enrollment.

Our faculties contain, all told, more than 120 teachers. Thirteen Professors, Assistant Professors, and Instructors give their entire time to mechanics, mechanical drawing, shop work, civil, electrical, and mechanical engineering, and courses designed especially for engineering students are given by a number of other teachers.

Our students come from almost every county in Missouri. Fifty-three states, territories, and foreign countries were represented here in the session of 1903-1904 by 1,649 students. The enrollment at Columbia in Engineering has increased in six years from 66 to 274. We cannot satisfy the demand for our graduates.

Requirements for Entrance.

A good high school education or its full equivalent and evidence of good character are demanded for admission. Those who cannot present diplomas from accredited secondary schools will be examined by the professors of our Academic department. Applications for admission should be addressed to "The Committee on Entrance, University of Missouri, Columbia, Mo."

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Catalogue. If this circular interests you, write for a catalogue of the University, to the Registrar, "Mr. Irvin Switzler, Columbia, Missouri." Persons thinking seriously of entering the University and wishing to see plates of its buildings, should write for them. If possible, see our great exhibit in the Educational Building at the World's Fair at St. Louis.

For further information address the Junior Dean,

H. B. Shaw,
Columbia, Mo.

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1905-06

Vol. VI—No. 8 August, 1905

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BULLETIN OF THE
UNIVERSITY OF MISSOURI

SCHOOL OF ENGINEERING

CIRCULAR OF INFORMATION

1905-1906

SESSION BEGINS SEPTEMBER 12

Published by
The University of Missouri
Issued monthly
Entered April 12, 1902, at Columbia, Missouri, as second-class matter
under act of Congress of July 16, 1894.

THE UNIVERSITY OF MISSOURI

The University of Missouri was located at Columbia, Missouri, in 1839, and courses of instruction in Academic work were begun in 1841. A Department of Education was established in 1867. The College of Agriculture and Mechanic Arts and the School of Mines and Metallurgy were made Departments of the University in 1870—the School of Mines being located at Rolla. The Law Department was opened in 1872; the Medical Department in 1873; the School of Engineering in 1877. The Experiment Station was established, under act of Congress, in 1888. The Missouri State Military School was created a Department in 1890. In 1896 the Graduate Department was established.

The University has the following buildings: The Academic Hall; separate buildings for Agriculture, Chemistry, Engineering, Geology and Zoology, Law, Mechanic Arts, and Medicine; the Parker Memorial Hospital; the Laws Observatory; the Power House; the President's house; Benton Hall and Lathrop Hall, two dormitories for men; the Gymnasium for men; the Agricultural Farm buildings and the Live Stock Judging and Dairy buildings; the horticultural building and green-houses, and Read Hall, the dormitory for women.

RESOURCES.

The buildings, grounds, books and other equipment, are valued at more than $1,600,000 not including the campus or the grounds for botany, horticulture and agriculture. The endowment (interest at 5 or 6 per cent), is $1,240,000. The income from the United States Government (Hatch and Morrill Acts) is $38,438 a year. The Legislature makes appropriations biennially. There is some income from fees for libraries and laboratories. There are 47,427 acres of unsold land. A State Collateral Inheritance Tax yields $120,000 or more a year. The income of the whole University, from all sources and for all Departments, in each of the years 1903 and 1904, was about $430,000.

THE SCHOOL OF ENGINEERING.

It is the aim of the School of Engineering to provide a substantial foundation for the general and technical knowledge needed by the successful engineer by giving its students thorough training in the fundamental principles which underlie all engineering practice, with such applications to problems met in the several fields of practice as may be feasible in a technical school. To this end five courses of instruction are offered, corresponding to various lines of practice, and leading respectively to the degrees of Bachelor of Science (B. S.) in Civil Engineering, Electrical Engineering, Mechanical Engineering, Sanitary Engineering and Chemical Engineering.

In each of these courses the first two years are mainly devoted to preliminary training in English, Mathematics, Physics, Chemistry, Drawing, Surveying and Shopwork as a preparation for the more technical work of the last two years which is given chiefly by the Engineering Departments.

The course in *Civil Engineering* covers a very wide field, embracing topographical, railway, hydraulic, structural, municipal, and sanitary engineering, and it is the aim to give a broad, general training which may later serve as a foundation for the development of any of the special lines of practice included under the general term, Civil Engineering.

The course in *Electrical Engineering* is intended to prepare students for electrical designing, manufacturing, contracting, and for the installation and management of light and power stations; in short, it is a thorough, broad training for Electrical Engineers. The technical work consists of the theory and principles of electricity and magnetism; electrical measurements; calibration of instruments; tests of all kinds; design and construction; study of special problems in the generation, transmission, distribution and utilization of electrical energy. Special attention is paid to alterating current phenomena.

The course in *Mechanical Engineering* is intended to fit students to enter readily any of the principal divisions of Mechanical Engineering. Training is given in the underlying principles of the profession, all work being so arranged that the application of these principles to special problems which may arise in practice, may clearly be seen. The design of engineering structures and machines, and the development, application and measurement of power in its various forms are covered in the different courses.

The course in *Sanitary Engineering* is arranged with the the purpose of combining a study of the principles of sanitary science with the fundamental training of the course in Civil Engineering.

The course in *Chemical Engineering* is offered to furnish training in engineering together with specialization in Chemistry. In view of the development of the applications of chemistry on a large scale in manufacturing, it is proposed to extend the course, making it more general on the engineering side, or to offer several parallel courses as the demands may require.

REQUIREMENTS FOR ADMISSION.

Fourteen (14) units are required for admission to the School of Engineering: but one (1) condition will be allowed. Beginning with June, 1906, fifteen (15) units will be required for admission, with two (2) conditions.

A unit represents the equivalent of a year's work of nine months in one subject, in a good high school, normal school or college with five periods a week in the class-room or laboratory, each period of about forty minutes.

Three of these units *must* be in English, one and one-half in Algebra, one in Plane Geometry. The additional units required may be selected from the following list.

English—one unit.

Solid Geometry or *Plane Trigonometry*—one-half unit.

Physics, Chemistry, Biology, Zoology, or *Botany*—one to two units.

Drawing, Manual Training, or *Physiography*—one unit.

History or *Latin*—one to four units.

German, French, Spanish or *Greek*—one to three units.

Beginning with June 1906, two units in foreign language and one unit in science will be a fixed requirement. It is strongly recommended that students present two units in French or German to meet the requirements in foreign language.

In 1907-8 one-half unit in Solid Geometry will be a fixed requirement in Engineering. The courses in Engineering require that the students be strong in mathematics and science. Those who are not strong in these lines are advised not to undertake work in Engineering.

Students from accredited schools will not be admitted subject to a condition unless they are graduates of such schools.

ENTRANCE EXAMINATIONS AND CERTIFICATES.

Examinations for admission will be held at the University September 11, 12, 13, 1905. All persons desiring to enter the University during the first semester of the session of 1905-6, except those holding certificates of graduation from Accredited Schools and those who have already fulfilled the entrance requirements must take these examinations.

The University will admit without examination such graduates of an Accredited School as bring proper credentials of the fact that they have completed the subjects required for entrance.

The diploma will not be accepted as a credential. The student must present the proper form of certificate signed by the Principal or Superintendent of the Accredited School. Blank certificates will be furnished by the Dean upon application. These certificates should be filled out and sent to the Committee on Entrance, Columbia, Missouri.

Students who do not hold certificates of graduation from an Accredited School may present their grades in any subject. In such cases they should have the grades certified to by the proper official of the school in which the grades were made.

As the necessity for correction appears in many instances, the student may avoid delay and inconvenience by sending certificates in advance of the opening of the session.

SPECIAL STUDENTS.

Persons who desire to follow special lines of work, and who have not had the preliminary preparation required for admission as regular students, may be admitted as special students for the purpose of pursuing courses for which their preparation fits them. Such students must satisfy the Dean that they can pursue the work selected with profit to themselves, and are required to maintain the same standard of excellence which is required of regular students. No special student may be a candidate for a degree until he makes up his entrance requirements and enters in regular standing before the beginning of the senior year.

ADVANCED STANDING.

Applicants for advanced standing are required to present credentials showing completion of courses equivalent to those for which they seek credit. Claims for advanced standing must be made by the student within one semester after entrance. Those who wish to have their claims passed upon before matriculation may present them at any time to the Dean.

FEES AND EXPENSES.

Tuition is free in all Departments of the University. Students in the School of Engineering, excepting state cadets, pay an annual entrance, library, and incidental fee of five dollars. A deposit of five dollars is required upon entrance into each laboratory course taken by the student. From this amount is deducted the fixed laboratory charge and any charges for materials or damage to property of the University, and the remainder is refunded to the student at the end of the session.

The estimated cost of board and room rent in the University dormitories for men varies from about $2.50 to about $3.50 per week. Board and lodging in private families may be had for from three and a half to five dollars a week. Private clubs also are formed in which the average cost is two and a half dollars a week. The rent of rooms is from seventy-five cents to one dollar and a half a week.

LIBRARY.

Each of the Engineering departments is equipped with an excellent working library of technical books, and the reading room is supplied with the best engineering magazines.

The general library of the University contains some 50,000 volumes and is open to all students of the University for consultation. Books may, under regulations, be drawn from the library. At present the general library occupies the west wing of Academic Hall.

The library and reading-room of the Missouri State Historical Society is also located in Academic Hall and is open for consultation to all students of the University.

ENGINEERING SOCIETY.

There is a flourishing Engineering Society composed of members of the junior and senior classes which affords opportunity for discussion of current engineering topics, and brings the students and faculty together in a social way.

ATHLETICS.

A new $70,000 gymnasium is now in course of construction. Work in physical training and athletics is thoroughly organized. The students have teams for football, baseball, basketball, track athletics and lawn tennis. There are excellent facilities for all forms of exercise—golf links, tracks, tennis courts, and several athletic fields.

COURSE IN CIVIL ENGINEERING.

Freshman Year.	*1st Sem.*	*2nd Sem.*	*No. of Course.*
Algebra, Trig. and Anal. Geom.	5	5	Math. 1aA, 2aE & 1bE
Composition and Rhetoric	3	3	English 1
General Inorganic Chemistry	3	3	Chemistry 2
Mechanical Drawing	3	0	Drawing 1a
Woodwork and Forging	2	0	Shopwork 1a
Descriptive Geometry	0	3	Drawing 2b
Topographical Drawing	1	0	Drawing 5a
Elementary Surveying	0	3	C. E. 1b

Sophomore Year.	*1st Sem.*	*2nd Sem.*	*No. of Course.*
Calculus	5	5	Math. 4E
Higher Sur. & Ry. Location	3	3	C. E. 2a & 4b
General Physics	6	6	Physics 3
Machine Dr. & Stereotomy	2	2	Drawing 4a & 6b
Elementary Construction	2	2	C. E. 6

Junior Year.	*1st Sem.*	*2nd Sem.*	*No. of Course.*
Mechanics of Engineering	5	5	Mechanics 3
Railway Engineering	3	0	C. E. 5a
Spher. and Prac. Astronomy	0	3	Astronomy 5b
Steam Engineering	3	0	M. E. 1a
Frame Structures	3	3	C. E. 10
Municipal Engineering	2	2	C. E. 7
Testing Laboratory	0	1	C. E. 14b
Materials of Construction	0	2	C. E. 19b

Senior Year.	*1st Sem.*	*2nd Sem.*	*No. of Course.*
Hydraulic Motors	2	0	M.E. 7a
Mechanical Lab	0	1	M. E. 11b
Geodetic Surveying	0	3	C. E. 3b
Hydraulics	2	0	C. E. 9a
Bridge Design	5	0	C. E. 11a
Theory of Structures	0	3	C. E. 12b
Masonry Structure	3	0	C. E. 13a
Testing Laboratory	1	0	C. E. 14a
Specifications & Contracts	0	1	C. E. 16b
Construction	0	2	C. E. 20b
Thesis	0	2	C. E. 30b
Elective	2 to 5	2 to 5	

COURSE IN ELECTRICAL ENGINEERING.

Freshman Year.	*1st Sem.*	*2nd Sem.*	*No. of Course.*
Trig., Algebra and Anal. Geom	5	5	Math. 1aE, 2aE & 1bE
Composition and Rhetoric	3	3	English 1
Genl. Inorganic Chemistry	3	3	Chemistry 2
Mech. Drawing and Des. Geom.	3	3	Drawing 1a and 2b
Woodwork and Forging	3	3	Shopwork 1

Sophomore Year.	*1st Sem.*	*2nd Sem.*	*No. of Course.*
Calculus	5	5	Math. 4E
General Physics	6	6	Physics 3
Machine Work	2	2	Shopwork 2
Elementary Surveying	2	0	C. E. 1a
Elements of Machine Drawing	0	2	Drawing 3b
Steam Eng. and Kinematics	3	3	M. E. 1a & 2b

Junior Year.	*1st Sem.*	*2nd Sem.*	*No. of Course.*
Mechanics of Engineering	5	5	Mechanics 3
Electrical Measurements	2	2	Physics 4
Electrical Machinery	4	4	E. E. 1
Alternating Currents	3	3	E. E. 2
Seminary	1	1	E. E. 6

Senior Year.	*1st Sem.*	*2nd Sem.*	*No. of Course.*
Hydraulic Motors	2	0	M. E. 7a
Mechanical Lab.	2	2	M. E. 13
Advanced Alt. Currents	3	3	E. E. 3
Electrical Design	3	3	E. E. 4
Electrical Engineering	3	3	E. E. 5
Seminary	2	2	E. E. 6
Thesis	0	2	E. E. 7b

COURSE IN MECHANICAL ENGINEERING.

The Freshman and Sophomore years are identical with those of the course in Electrical Engineering.

Junior Year.	*1st Sem.*	*2nd Sem.*	*No. of Course.*
Steam Boilers	3	1	M. E. 3
Thermodynamics	0	3	M. E. 4b
Mechanical Laboratory	1	1	M. E. 11
Graphics of Machines	2	0	M. E. 14a
Electrical Machinery	4	3	E. E. 1
Mill Structures	0	2	C. E. 18b
Mechanics of Engineering	5	5	Mechanics 8

Senior Year.	*1st Sem.*	*2nd Sem.*	*No. of Course.*
Heat Engines	3	0	M. E. 5a
Steam Engine Design	3	2	M. E. 6
Hyd. Motors and Pumping Mach.	2	2	M. E. 7a and 8b
Machine Design	2	2	M. E. 9
Mechanical Lab.	2	1	M. E. 12
Thesis	0	2	M. E. 19b
Alternating Currents	3	3	E. E. 2
Contracts and Specifications	0	1	C. E. 16b
Electives	0 to 3	2 to 5	

COURSE IN SANITARY ENGINEERING.

The Freshman and Sophomore years are identical with those of the course in Civil Engineering. In the Junior year Technical Chemistry (Chem. 12) is substituted for the Railway Engineering and Astronomy of the C. E. Course.

Senior Year.	*1st Sem.*	*2nd Sem.*	*No. of Course.*
Mechanical Laboratory	0	1	M. E. 11b
Hygiene and Gen. Bacteriology	3	3	Bact. 1a and 7b
Bridge Design	5	0	C. E. 11a
Hydraulics	2	0	C. E. 9a
Specification and Contracts	0	1	C. E. 16b
Masonry Structures	3	0	C. E. 13a
Sanitary Engineering	0	3	C. E. 8b
Engineering Laboratory	1	0	C. E. 14a
Hyd. Motors and Pumping Mach.	2	2	M.E. 7a and 8b
Construction	0	2	C. E. 20b
Thesis	0	2	C. E. 21b

COURSE IN CHEMICAL ENGINEERING.

Freshman Year.	*1st Sem.*	*2nd Sem.*	*No. of Course.*
Trig. and Anal. Geom.	3	5	Math. 1aE and 1bE
Composition and Rhetoric	3	3	English 1
General Inorganic Chem.	3	3	Chemistry 2
Mechan. Drawing and Des. Geom.	3	3	Drawing 1a and 2b
Steam Eng. and Kinematics	3	3	M. E. 1a and 2b

Sophomore Year.	*1st Sem.*	*2nd Sem.*	*No. of Course.*
General Physics	6	6	Physics 3
Calculus	5	5	Math. 4E
Organic Chemistry	3	3	

Junior Year.	*1st Sem.*	*2nd Sem.*	*No. of Course.*
Mechanics of Engineering	5	5	Mechanics 3
Technical Chemistry	3	3	Chemistry 12
Electrical Measurements	2	2	Physics 4
Thermodynamics	0	3	M. E. 4b
Electrical Machinery	4	4	E. E. 1
Elements of Machine Drawing	0	2	Drawing 3b

Senior Year.	*1st Sem.*	*2nd Sem.*	*No. of Course*
Physical Chemistry	3	3	Chemistry 10
Plants and Processes	1	1	M. E. 15
Heat Engines	3	0	M. E. 5a
Elective (to be chosen from Chemistry, E. E. and M. E.)	8	8	
Thesis	0	3	

ADVANCED DEGREES.

The degree of Civil Engineer (C. E.), Electrical Engineer (E. E.), and Mechanical Engineer (M. E.) will be conferred on candidates who, after receiving the first degree from this University, or from one of equivalent standing, have spent in the same course one year (at least ten hours a week) in graduate work in the University, or two years in professional practice and graduate work *in absentia*. The candidate must pass an examination on his graduate work and present a satisfactory thesis. The thesis subject shall be presented to the Dean on or before November 1, and the thesis shall be presented on or before May 1st of the given year. Those who with professional practice pursue graduate work *in absentia* must be regularly enrolled as graduate students, paying the usual fees.

DEPARTMENTS OF INSTRUCTION.

Civil Engineering.

F. P. Spalding, Professor ; W. S. Williams, A. Lincoln Hyde, Assistant Professors ; L. M. Fry, Assistant.

This department is well equipped with instruments for teaching and surveying. There are 14 transits, 9 levels, 2 plane tables, 4 compasses, sextants, tapes, and small instruments for land topographical and railway surveys; and an 8-inch Fauth theodolite, Brandis triangulation transit, Saegmuller precise level, base apparatus, etc., for geodetic surveys.

In the laboratory for testing materials there are, a Standard abrasion cylinder for paving brick, three testing machines arranged for tension, compression and transverse tests, an Olsen torsion machine, extensometers, deflective gages, compression micrometers, and small tools and instruments needed for tests of iron, steel, wood, brick, etc. The cement laboratory is fitted for all of the standard tests. There are Olsen and Fairbanks testing machines, mortar mixer, briquette press, apparatus for heat tests, Vicat and Gilmore needles for rate of setting, appliances for fineness and specific gravity tests, glass mixing tables, and a good outfit of molds and other small instruments.

For office work there are rolling and polar planimeters, a pantagraph, topographical protractors, stadia charts and slide rule, Thatcher calculating instrument, beam compass, etc. About 500 drawings of recent bridges, presented by Mr. T. G. Wilkerson (class of 1890) of Pittsburg, and a set of 130 drawings, carefully arranged, indexed, and presented by Dr. J. A. L. Waddell, illustrating recent practice in bridge design, are available for instruction.

1a. **Elementary Surveying.** Use and adjustment of ordinary surveying instruments. Methods employed in land and topographical surveying. Course for Sophomores in Electrical and Mechanical Engineering. M. F., 1:30-4; W., 1:30-4; S., 9-11:30; T. Th., 1:30-4. Assistant Professor Williams and Mr. Fry.

1b. **Elementary Surveying.** Course for Freshmen in Civil Engineering. M. W. F., 1:30-4; M. W. F., 9-11:30; T. Th., 1:30-4; S., 9-11:30; T. Th. F., 10-12:30. Assistant Professor Williams and Mr. Fry.

2a. **Higher Surveying.** City, topographical, mining, and hydrographic surveying. T. Th., 8-10; S., 8-11:30; M., 8-11:30, W. F., 10:30-12:30. Assistant Professor Williams and Mr. Fry.

3b. **Geodetic Surveying.** Elements of Geodesy with practice in use of precise instruments and reduction of triangulation. Precise level work. Determinations of azimuth. M. W. F., 1:30-4. Assistant Professor WILLIAMS.

4b. **Railway Location.** Theory and practice of railroad surveying, including the field location for a short line of railway. T. Th., 8-10; S., 8-11:30; M., 8-11:30; W. F., 10:30-12:30. Assistant Piofessor WILLIAMS and Mr. FRY.

5a. **Railway Engineering.** Complete estimate for railway line; track construction; railway structures; railway economics. T. Th. 1:30-5, S., 1:30-2:30; M. W., 9-12:30, F., 9-10. Assistant Professor WILLIAMS and Mr. FRY.

6. **Elementary Construction.** Material and methods employed in engineering construction; masonry construction; roads and pavements. W. F., at 9. Professor SPALDING.

7. **Municipal Engineering.** Discussion of general problems of municipal public works, with more detailed study of water supply and sewerage. *First Semester*, T. Th., 10:30; *Second Semester*, M. W., 10:30. Professor SPALDING.

8b. **Sanitary Engineering.** Sewerage disposal, water purification and general sanitation. M. F., 11:30. Professor SPALDING.

9a. **Hydraulics.** Problems in hydraulics; conduits; pipe lines; water towers and stand pipes; dams and gates; measuring devices, etc. T. Th., at 9. Professor SPALDING.

10. **Framed Structures.** Analysis of simple trusses. Graphic statics. Design for small roof truss. M. W. F., 1:30-4. Assistant Professor HYDE.

11a. **Bridge Design.** Design for plate girder bridge and steel railway bridge of short span, with working drawings and estimates. M. W. F., 8-10; T. Th., 10:30-12:30. Assistant Professor HYDE.

12b. **Theory of Structures.** Swing bridges, arches, suspensions and cantilever bridges, deflection of trusses. T. Th. S., at 8. Assistant Professor HYDE.

13a. **Masonry Structures.** Theory of masonry and concrete structures; reinforced concrete; design and estimate for masonry arch. M. W. F., 1:30-4. Professor SPALDING.

14b. **Testing Laboratory.** Tests for strength and elasticity of wood, iron, and steel in tension, compression, torsion and flexure; standard tests for cement and for paving brick. T., 1:30-4; Th., 1-30-4. Assistant Professor HYDE.

14a. **Testing Laboratory.** Continuation of Course 14b, with independent investigations by students. S., 9-11:30 or T., 1:30-4. Assistant Professor HYDE.

15. **Hydraulic Engineering.**(a) Institutions and practice of irrigation; a discussion of special problems arising in irrigation work.

First Semester, W. F., 10:30. (b) Rivers, canals, harbors, docks, etc. *Second Semester*, T. Th., 10.30. Professor SPALDING.

16b. **Specifications and Contracts.** S., 10:30. Professor SPALDING.

17b. **Geodesy.** T. Th. 10:30. Assistant Professor WILLIAMS.

18a. **Mill Structures.** Graphical analysis of framed structures; designs for simple roof truss, plate girder, and building details. M. W., 9-11:30. Assistant Professor HYDE.

19b. **Materials of Construction.** Properties of the more common materials used in engineering construction, with description of processes of manufacture and methods of testing and inspection. T. Th., 11:30. Professor SPALDING.

20b. **Construction.** Methods employed in engineering construction; foundations; walls; embankments; tunnels; hydraulic construction. T. Th., 9. Professor SPALDING.

30b. **Thesis.** An independent investigation or design with complete report or discussion of results.

For Graduates.

31. **Railway Engineering.** Special advanced courses in construction, maintenance and management. *Three to six hours a week.*

32. **Bridge Engineering.** Problems in theory and design of framed structures. *Three to six hours a week.* Assistant Professor HYDE.

33. **Sanitary Engineering.** Investigations and special problems in Sanitary Science. *Three to six hours a week.* Professor SPALDING.

34. **Hydraulic Engineering.** Problems in hydraulics, irrigation, river and harbor improvements. Hydraulic constructions. *Three to six hours a week.* Professor SPALDING.

35. **Concrete Structures.** Theory of reinforced concrete. Special laboratory investigations. *Three to six hours a week.* Professor SPALDING and Assistant Professor HYDE.

Electrical Engineering.

H. B. SHAW, Professor; A. E. FLOWERS, Instructor; D. W. RICHARDS, Assistant.

The aim of the course is to furnish thorough training for Electrical Engineers. For this purpose the individual studies have been very carefully selected and arranged, the technical subjects being varied slightly from year to year to meet the demands of a rapidly developing profession. The first two years are devoted to preliminary training in English, Mathematics, the Sciences, and in Drawing and Shopwork. Studies 1 to 7b on the following page are given in the junior and senior years.

Instruction is given by means of recitations, lectures, and laboratory work thoroughly correlated, the idea being to present the subject to the student as a whole, and from all points of view. A feature of considerable interest in the work is the student meetings of the American Institute of Electrical Engineers held in connection with the Seminar. The department of Physics has charge of the special course —lectures and laboratory work—in Electrical Measurement for students in Electrical Engineering.

Attention is called to the studies, Steam Engineering, Kinematics, Hydraulic Motors, and Mechanical Laboratory under the direct charge of the department of Mechanical Engineering.

For the laboratory work in Electrical Engineering distinctively there are the following laboratories: Dynamo laboratory for Direct and Alternating Currents. Standardizing laboratory for the calibration of instruments, laboratory for the testing of materials used in Electrical Construction. These laboratories are already fairly well equipped wifh different types, makes and sizes of motors and generators, together with ammeters, volt-meters and other instruments and accessories. Apparatus is being continually added as necessary. Facilities for research work are continually being improved, each student being required to present a thesis evidencing original research. As the result of such research work may be mentioned a 40,000 volt testing transformer and an oscillograph constructed by students.

1. **Electrical Machinery.** Theory, construction, and operation of continuous current generators, motors, measuring instruments and accessories. Laboratory: characteristics, efficiencies, heating tests, diseases and remedies. Lecture: F., at 9. Recitations: I. Th., at 9, II. Th., at 8. Laboratory I. T. Th., 1:30–4; II. M. W., 10-12:30. Professor SHAW and Mr. RICHARDS.

2. **Alternating Currents.** Alternating current phenomena. Theory of current flow. Single and multiphase generators, motors, transformers, and instruments. T. Th. S., at 11.30. Mr. FLOWERS.

3. **Advanced Alternating Currents.** A continuation of course 2 with laboratory tests as to operation, regulation, efficiency, etc. M. W. F., 1:30-4. Professor SHAW and MR. RICHARDS.

4. **Electrical Design.** Critical study of electrical apparatus and design of rheostats, transformers, generators, motors, and switchboards. M. W. F., 8-10. Mr. FLOWERS.

5. **Electrical Engineering.** The generation, transmission, distribution and utilization of electrical energy. Study of lighting, power, and transmission systems, including street railways, with regard to estimates and specifications, selection and arrangement of machinery, installation, testing, operation, and management. M. W. F., at 11:30. Professor SHAW.

6. **Seminary.** Discussion of current technical literature. Student meetings of the American Institute of Electrical Engineers are held

regularly, and work for the same will constitute part of the course. Juniors, T., 10:30; Seniors, T. F., 10:30. Professor SHAW.

7b. **Thesis.** Original investigations, and presentation of results in the form of a final thesis. Hours to be arranged.

Primarily for Graduates.

8. **Design.** Special problems. Thorough study and design of a single piece of apparatus, such as an induction motor, direct current generator, or rotary. Hours to be arranged. Mr. FLOWERS.

9. **Telephony and Telegraphy.** Apparatus and systems. Lines: their properties, with special reference to effects of inductance and capacity. Wireless telegraphy. Hours to be arranged. Professor SHAW.

10. **Long Distance Transmission.** A thorough study of details. Hours to be arranged. Professor SHAW.

11. **Electric Railway Engineering.** Street, interurban and high speed electric railroading. Electric railway economics. Hours to be arranged. Mr. FLOWERS.

12. **Storage Battery Engineering.** Hours to be arranged. Professor SHAW.

13. **Electrical Engineering Economics.** Hours to be arranged. Professor SHAW.

14. **Research.** Work and hours to be arranged to suit individuals. Professor SHAW and Mr. FLOWERS.

Mechanical Engineering.

A. M. GREENE, JR., Professor; A. F. VAN DEINSE, Instructor; J. R. WHARTON, Assistant.

The aim of this course is to train the student in the underlying principles of the profession so as to enable him to readily take up any special branch of Mechanical Engineering. For this purpose the design of engineering structures and machines and the application, measurement and production of power are studied. Instruction is given principally by the aid of text books and laboratory work, lectures being used in few of the courses and to supplement the text books. In the class rooms advanced problems taken principally from practice are given for solution, the aim being to prepare the student for the practical work which is to come after graduation.

The department is equipped with an excellent working library of books which are always accessible to the student. The reading room, which is also open at all times, is supplied with the best engineering magazines. The laboratory is equipped with steam, gas and oil engines, steam turbine, water wheels, injectors, pumps, air compressors, fans, blowers, hoisting appliances, and apparatus for testing the standardising instruments. A large number of indicators, planimeters, thermometers, and water meters are used on tests, and the properties of oils, coals, transmission material and gases are determined by apparatus for these purposes.

The work in the laboratory is to familiarize the student with the use and the care of these machines as well as the principles underlying their design, construction and use. In equipping the laboratory it has been the aim to select apparatus which would bring the student in contact with most of the important forms or types of machines for developing and measuring power. It is also the intention to have him make most of the tests which a mechanical engineer is called upon to execute, and at the same time an attempt is made to have the student make original investigations on simple problems.

1a. **Steam Engineering.** Fuels, boilers, engines and accessories. An elementary descriptive course intended to give the student the names, purposes, construction and operation of the various parts of the apparatus found in a steam power plant. T. Th. S., at 9; T. Th. S., 11:30. Professor GREENE, Mr. VAN DEINSE.

2b. **Kinematics.** Elementary mechanisms: pulleys, belts, link work, gearing, cams. T. Th. S., at 9; T. Th. S., at 11:30. Mr. VAN DEINSE.

3. **Steam Boilers.** Value of fuels, determination of the sizes of grate, heating surface, stays, and chimney, for a given boiler. Types of boilers for various purposes, methods of testing boilers. Boiler room accessories. Design of a boiler house. Each student is required to make a working drawing of a boiler designed by him. This course must be preceded by or taken co-ordinately with Mech. 3. *First Semester*, M. W., at 9; F., 10:30-12:30; *Second Semester*, F., 10:30-12:30. Mr. VAN DEINSE.

4b. **Thermodynamics.** Mechanical theory of heat. Cycles and analyses. T. Th. S., 10:30. Professor GREENE.

5a. **Heat Engines.** The application of thermodynamics to the various forms of heat engines, air compressors, and refrigerating machines. Form of plants using such apparatus. Discussion of tests, installation and maintenance. This course must be preceded by course 4. T. Th. S., 10:30. Protessor GREENE.

6. **Steam Engine Design.** The determination of the size of the parts of a steam engine to develop a given power. Discussions of vibrations, fly wheels, balancing, transmission of power by belts, ropes and gears, steam piping, shafts. Each student is required to make free-hand sketches of the various parts of the complete engine as designed by him. Must be preceded by Mech. 3 and M. E. 1 and 2. *First Semester*, M. W. F., 10:30-12:30; *Second Semester*, W. F., 10:30-12:30. Professor GREENE.

7a. **Hydraulic Motors.** The theory of the action of turbines, measurement of power, discussion of experiments, design of wheels for specific duty. Must be preceded by Mech. 3. T., 8-10; Th., at 8. Professor GREENE.

8b. **Pumping Machinery.** The design of pumps for waterworks and power transmission. Hydraulic presses and machinery. Pipe lines. Plants. T. Th., at 8. Professor GREENE.

9. **Machine Design.** Design of special machinery. Continuation of work in mechanical drawing and engineering mechanics. The student is required to design a machine tool, crane, pump, girder, or some similar engineering structure and make finished working drawings of the same. Must be preceded by Drawing 1 and 2 and Mech. 3. T. Th., 1:30-4. Mr. VAN DEINSE.

10b. **Heating and Ventilating.** The arrangement and design of systems for heating and ventilating buildings. Application to a specific building. Elective for Seniors. T. Th., at 9. Professor GREENE.

11. **Mechanical Laboratory.** The calibration and adjustment of instruments, measurements of leverage, determination of the efficiency of machines, tests of materials of engineering, measurements of power, hydraulic measurements, valve setting, coal and gas calorimetry. W., 1:30-4. Mr. VAN DEINSE.

12. **Mechanical Laboratory.** Testing boilers, engines, pumps, turbines, injectors, air compressors, and refrigerating machinery for efficiency and duty. Studies in generation, transmission and application of power. Heating and ventilating. Calorimetry. *First Semester*, M. F., 1:30-4; *Second Semester*, F., 1:30-4. Professor GREENE.

13. **Mechanical Laboratory.** A course for electrical engineers. Calibration of instruments and tests of engines, pumps, turbines, and boilers for efficiency and duty. T., 1:30-6. Professor GREENE.

14a. **Graphics of Machines.** Graphical Analysis of machines. Moment diagrams for shafts, friction of axles, gears, screws. M., 1:30-4; W., 10:30-12:30. Mr. VAN DEINSE.

15. **Plants and Processes.** A course in the layout and arrangement of plants for different engineering works. Engineering manufacturing processes. Elective for Juniors and Seniors. F., 8-10. Professor GREENE.

16a. **Valve Gears.** A study of the various forms of gears and their design, using the Zeuner and Bilgram diagrams. Elective for Juniors and Seniors. M., 10:30-12:30. Mr. VAN DEINSE.

17. **Marine Engineering.** A study of the marine engine and boiler together with the auxiliary machinery used on shipboard. Elective for Juniors and Seniors. Given in alternate years, beginning 1904-5. M., 8. Professor GREENE.

18. **Naval Architecture.** Buoyancy, stability, metacentric heights, weights, curves, strength, propulsion and steering. Elective for Juniors and Seniors. Given in alternate years, beginning 1903-4. M., 8. Professor GREENE.

19b. **Thesis.** An original investigation of an engineering problem. M., 9-12:30, 1:30-4. Professor GREENE.

20. **Technical Literature.** Reports on reading of technical magazines. S., at 9.

Students in Civil and Electrical Engineering with the required training may elect any of the above courses with the consent of the head of the department in which they are working.

Primarily for Graduates.

21. **Generation of Power.** Advanced work in the Theory and Design of steam, gas and oil engines, air compressors and motors, steam turbines and hydraulic motors. Hours to be arranged. Professor GREENE.

22. **Transmission of Power.** Study of methods of the transmission of power, heating, lighting, and arrangement of shops, plants, industrial institutions and towns. Transportation of materials. Hours to be arranged. Professor GREENE.

23. **Advanced Laboratory Work.** Determination of physical characteristics of fuels, oils, metals. Thermodynamics of heat engines. Tests of complete plants. Original Investigations. Hours to be arranged. Professor GREENE.

24. **Railway Engineering.** Design, construction and operation of motive power, rolling stock and the auxiliary apparatus employed. Hours to be arranged. Mr. VAN DEINSE.

25. **Kinematics and Machine Design.** Advanced work in Kinematics and the design of apparatus for specific work. Hours to be arranged. Mr. VAN DEINSE.

26. **Refrigeration.** Advanced work in the layout and operation of Plants for Refrigeration. Hours to be arranged. Professor GREENE.

27. **Engineering Office Work.** Keeping of costs, estimates, organization of shops, advertising. Hours to be arranged. Professor GREENE and Mr. VAN DEINSE.

Mechanics.

L. M. DEFOE, Professor.

3. **Mechanics of Engineering.** Statics, dynamics, strength of materials, hydrostatics and hydrodynamics. Lectures, W. F., at 8; Recitations, Section I, T. Th. S., at 8; Section II, T. Th. S., at 9.

4. **Elasticity.** Mathematical theory of elasticity. T. Th. S., at 10:30.

9. **Hydromechanics.** An elementary course in hydrostatics and hydrodynamics. M. W. F., at 10:30.

12. **Fourier's Series and Potential Functions.** Recitations and lectures. Hours to be arranged.

20. **Problems in Mechanics.** Dynamics of a rigid body. M. W. F., at 11:30.

27. **Theory of Sound,** with special reference to the Partial Differential Equations of Mathematical Physics. Reading Course, based on Rayleigh's Theory of Sound. *Three hours.* Hours to be arranged.

Mathematics.

E. R. Hedrick, Professor; G. A. Bliss, Assistant Professor; L. D. Ames, Louis Ingold, Instructors; Emily E. Dobbin, Mary S. Walker, Assistants.

1. (E). **Trigonometry.** *Three hours.* This course may be taken *only* together with 2a (E) or 2a, and therefore contains no algebra. Eight sections. Hours and instructors posted in advance.

1b. (E). **Plane (and Solid) Analytic Geometry.** *Five hours.* This course will also contain introductory work on graphs, and will include the Solid Analytic Geometry. Eight sections. Hours and instructors will follow 1a (E).

2a. (E). **Advanced Algebra.** *Two hours.* Open only to those who have offered one and one-half units of Algebra for entrance. Eight sections. Hours and instructors posted in advance.

4. (E). **Differential and Integral Calculus, with Applications.** *Five hours.* This course should be elected by those who feel inclined toward mathematics; in it they can decide whether or not they can succeed in further mathematical work. The course will be followed by short supplementary courses on Differential Equations and on the Applications to Mechanics. Five sections. Hours and instructors posted in advance.

6b. **Theory of Equations and Determinants.** Recitations, following Burnside and Panton. Theory of Equations. *Three hours.* Hours to be arranged. Mr. Ingold.

10b. **Elements of Differential Equations.** Problem course. Recitations, supplemented by reading and recitations. Text: Forsyth, Differential Equations. *Three hours.* Hours to be arranged. Mr. Ingold.

Other courses in mathematical subjects given in Academic Department and Teachers College are open to Engineering Students.

Astronomy.

F. H. Seares, Professor.

The practical work of the Department of Astronomy is carried on with the instruments of the Laws Observatory.

The observatory is a building 84 feet long and from 14 to 30 feet wide. The equipment consists of a 7 1-2 inch equatorial refracting telescope by Merz and Soehne, of Munich, a 2 1-10 inch transit instrument by Brunner, of Paris, a 2 1-8 inch altitude and azimuth instrument by E. & G. W. Blunt of New York, a Pickering stellar photometer and a disc photometer by Brashear, a theodolite, sidereal and mean-time clocks, sidereal break circuit chronometer, chronograph, sextants, micrometer, spectroscope, and outfit of smaller instruments.

Clocks and instruments are mounted on piers of solid masonry, isolated from the floors and walls of the buildings, and are provided with the usual electrical connections. The dome covering the telescope is 18 feet in diameter. A cone 14 feet in diameter, revolving on balls, shelters the altitude and azimuth instrument.

3a. **General Astronomy.** Open to students of junior standing who have completed the courses in Elementary Mathematics and General Physics. M. W. F., at 9.

4a. **Observatory Practice.** Practical work with the instruments of the Laws Observatory. Open to students taking course 3a. T. Th., 7:30-10 P. M.

5b. **Spherical and Practical Astronomy.** Open to students who have completed Differential and Integral Calculus and General Physics. T. Th., at 10:30; one Observatory period, hours to be arranged.

6a. **Spherical and Practical Astronomy.** Open to students who have completed course 5b. Lectures and Recitations. T., at 10:30; Observatory practice. T. Th., 7:30-10 P. M.

8b. **Method of Least Squares**, with applications to the problems of Astronomy and Geodesy. M. W., at 10:30.

10. **Celestial Mechanics, General Introduction and Theory of Cometary Orbits.** Open to students who have completed Analytic Mechanics and Elementary Differential Equations and who have a reading knowledge of French and German. Hours to be arranged.

Chemistry.

W. G. BROWN, Professor; SIDNEY CALVERT, HERMAN SCHLUNDT,
Assistant Professors; H. W. DOUGHTY, E. E. MORLAN,
Instructors; F. W. LIEPSNER, Assistant.

1. **General Inorganic Chemistry.** Lectures, laboratory work, problems and recitations. Lectures, Section I, M. W., at 9, and Section II, M. W., at 11:30; Recitation, F., at 8, 9, 10:30 and 11:30; Laboratory (see schedule of hours). *Six hours.*

2. **General Inorganic Chemistry.** Lectures, laboratory work problems and recitations. Lectures, Section I, M. W., at 9, and Section II, M. W., at 11:30; Recitation, F., at 8, 9, 10:30 and 11:30; Laboratory (see schedule of hours). *Four hours.*

5a or 5. **Qualitative Chemical Analysis.** Laboratory work, recitations and lectures. M. W. F., at 1:30. *Three times a week.*

6a and 6b. **Quantitative Chemical Analysis.** Laboratory work. *Three times a week.*

4. **Organic Chemistry.** Lectures and recitations. M. W., at 4; laboratory (one). *Three hours.* Assistant Professor CALVERT.

4. **Organic Chemistry.** Lectures and recitations (the same as 4). Laboratory (two). *Four hours.* Assistant Professor CALVERT.

7. **Preparation of Organic Compounds and Organic Analysis.** *Three times a week.* Assistant Professor CALVERT.

8b. **Chemical Theory.** Lectures and recitations. *Three times a week.*

9a. **History of Chemistry.** Lectures and recitations. *Three times a week.*

Courses 8b and 9a should be preceded by courses 1 or 2 and 4.

10. **Physical Chemistry.** Lectures, laboratory work, and recitations. *Three times a week.* Dr. SCHLUNDT.

11a. **Electro-Chemistry.** Lectures, laboratory work, and recitations. *Three times a week.* Dr. SCHLUNDT.

12. **Technical Chemistry.** *Three times a week.* Required of Chemical Engineering students.

14. **Inorganic Preparations.** *Three times a week.*

15. **Advanced Quantitative Chemical Analysis.** *Six times a week.*

16a or 16b. **Advanced Organic Chemistry.** Selected chapters. Lectures. *Three times a week.* Assistant Professor CALVERT.

17. **Quantitative Organic Analysis.** The determination of the proximate constituents of natural (vegetable and animal) and artificial organic substances. *Three times a week.* Assistant Professor CALVERT.

18a or 18b. **Radio-activity.** Lectures, experimental work and recitations on the radio-active types of matter and atomic disintegration. *Three times a week.* Dr. SCHLUNDT.

Primarily for Graduates.

20. **Research.** This will consist principally of original work and investigation in Inorganic, Organic, and Physical Chemistry, and will be adapted in some measure to individual cases.

A meeting is held weekly, at which reports on current literature, abstracts of special lines of research and the results and progress of investigations are presented for the information and discussion of those particularly interested in Chemistry and its applications. F., at 3:30.

Physics.

O. M. STEWART, Professor; C. A. PROCTOR, H. M. REESE, Instructors;
H. E. HOWE, Assistant.

Instruction in the elements of Physics is by means of lectures, quizzes and laboratory work. In the lectures the general principles of heat, sound, mechanics, optics, magnetism and electricity are given and illustrated at all stages by demonstration experiments. The large collection of lecture room apparatus possessed by the department makes it possible to illustrate all the more important phenomena. The laboratory work is designed to enable the student to obtain clearer conceptions of the fundamental principles and phenomena, and to give an opportunity to attain some skill in the use of instruments and a knowledge of the simpler methods of physical manipulation.

In the laboratory for electrical measurements is found a valuable collection of galvanometers, resistances, condensers, electrometers standards of electromotive force and resistance, self-induction, capacity, etc. The student is instructed in the important methods of comparing and calibrating instruments by such methods as Kelvin double bridge, potentiometers, etc.

The laboratory for advanced work in general physics contains standards of length, mass and temperature, and many pieces of high grade apparatus. The entire equipment has cost more than $10,000.

3. **General Physics.** A longer elementary course—an elementary knowledge ot Trigonometry is required. *Six times a week.* For 1905-6 this will be divided into courses 3A and 3B. 3A may be taken alone. 3B may be taken in conjunction with 3A or subsequently.

3A. **Lectures and Recitations.** *Four times a week.* Lectures T. Th., at 10:30 or W. F., at 10:30. Assistant Professor STEWART. Recitations: Section I, W. F., 1:30; Section II, T. Th., 8; Section III, W. F., 11:30; Section IV, W. F., 8; Section V, T. Th., 11:30. Professor STEWART; Mr. PROCTOR; Dr. REESE.

3B. **Laboratory.** *Twice a week.* Section I, W. F., 8-10:30; Section II, M. F., 1:30-4; Section III, T. Th., 9-11:30; Section IV, M., 8-10:30, W., 1:30-4; Section V, T. Th., 1:30-4. Mr. PROCTOR; Dr. REESE; Mr. HOWE.

4. **Electrical Measurements.** *Two or three times a week.* Lectures, M., 9. Laboratory, W. Th., 1:30-4. A knowledge of Calculus is required. Professor STEWART.

7. **Theory of Electricity and Magnetism.** *Three times a week.* M. W. F., at 11:30. Professor STEWART.

10. **Seminary.** Critical reading and discussion of current research work in physics. A colloquium in which all members of the teaching staff of the department and students of sufficient attainments take part. *Once a week.* M., at 4.

11. **Research Work.** Hours to be arranged. Professor STEWART.

Drawing.

T. J. RODHOUSE, Instructor (in charge); E. F. ROBINSON,
OMER DENNY, Assistants.

Instruction is given to all regular Engineering students in the principles of geometrical and mechanical drawing and in freehand sketching. A large amount of time is devoted to practice in the drawing-room to enable the student to acquire the skill necessary for his future work. Drawing is continued also in connection with the student's professional studies.

1a. **Mechanical Drawing.** Selected geometrical problems. Shading and sectioning; tracing; isometric drawing; mechanical lettering and plain freehand lettering. I. T. Th. S., 10:30-12:30; II. T. Th. S., 8-10; III. M. W. F., 1:30-3:30; IV. M. W. F., 10:30-12:30; V. M., 8-10; T. Th., 1:30-3:30; VI. T. Th. S., 10:30-12:30; VII. M. W. F., 8-10; VIII. T. Th. S., 8 10.

2b. **Descriptive Geometry.** Orthographic projections, problems relating to points, lines, and planes, preceded by a short course in elementary mechanical lettering and plain freehand lettering. Representation of surfaces, their tangencies, intersections and developments. Shades and shadows. Isometric, cabinet, and perspective views. Schedule same as 1a.

3a. **Machine Drawing.** See 3b for statement of course. IV. T. Th., 1:30-4; V. M. F., 1:30-4.

3b. **Machine Drawing.** Assembly drawings and tracings are made from especially prepared sketches of details for the purpose of familiarizing the student with conventions used in engineering practice. The parts of complete machines of approved design are then sketched freehand and the dimensions given on the sketches. Working drawings, assembly and detail, are made from these sketches without further reference to the parts. Blue prints are made by each student from his own tracings. I. M. F., 1:30-4; II. W., 1:30-4; S., 9-11:30; III. T. Th., 1:30-4.

5a. **Topographical Drawing.** Topographical signs; map drawing, V. F., 1:30-4; VI. M., 9-11:30; VII. W., 1:30-4; VIII. F., 10-12:30.

6b. **Stereotomy.** Problems in stone-cutting; drawings for masonry structures. IV. T. Th., 1:30-4; V. M. F., 1:30-4.

Shops.

W. H. Cook, Instructor (in charge); A. C. Duncan, Instructor; M. S. Bowen, A. W. Spaht, Assistants.

The shops of the Engineering school are intended primarily to give the student an idea of the properties of the various materials used in engineering, as well as to teach the methods of using tools. This work is carried on in the joinery shop, the pattern shop, the forge shop and the machine shop. In the first of these the student receives instruction in the manner of handling wood for structural purposes, the fundamental points of form being emphasized. Instruction is also given in the care and manipulation of all kinds of wood-working tools.

In the pattern shop the student is taught, not only the methods of constructing patterns, but also the peculiarities of melted metals, and the design of patterns for the purpose of making an efficient casting.

It is the intention to test the patterns studied in this course by actually making castings from patterns constructed by the student.

In the forge shop the fundamental operation of reducing, upsetting, welding and general forging are taught as well as the methods employed in tool making. The students are required to construct different tools and temper them for different purposes.

In the machine shops the fundamental operations are taught and a comparative study is made of the different methods of producing certain results. The time element for the different operations is studied, and it is the intention to have the student trained in selecting the best method for machining the various portions of a structure as well as to know the manner in which these operations may be performed. The intention in this work is to bring the student in contact with the modern methods of shop practice.

The equipment of the various shops is large enough to accommodate sections of twenty-four students. In the joinery shop work-benches and tools are supplied for each student, and in the pattern shop wood turning lathes are provided in addition to the work-benches for pattern-making. The forge shop is supplied with individual forges and anvils, and a power hammer is used for the purpose of reducing large stock, or for performing special work.

The machine shop is equipped with engine lathes, a planer, two shapers, a Universal milling machine, a Universal grinder, a screw machine, a drill press and two power saws, in addition to the emery wheels and small tools. Several vises are equipped with proper tools for bench work.

1. **Wood-work, Forging, Pattern-making and Foundry Practice.** *Six hours a week,* five sections.

1a. **Wood-work and Forging.** *Four hours a week,* four sections.

2. **Machine Work.** The aim of this course is to give the student an acquaintance with the improved methods of machine construction and of modern machine shop practice. Chipping, filing, and fitting, as well as the assembling of small machines, are carefully supervised and graded. *Five hours a week,* three sections.

3. **Advanced Machine Work.** This course is intended for students who desire to specialize in this work, and requires more experience than course 2 will give. This course will be given, if there is a demand for it.

For further information concerning the School of Engineering, address F. P. Spalding, Junior Dean, Columbia, Mo.

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VOL. VII—NO. 8. AUGUST, 1906

BULLETIN OF THE

UNIVERSITY OF MISSOURI

SCHOOL OF ENGINEERING

CIRCULAR OF INFORMATION

1906-1907

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UNIVERSITY OF ILLINOIS

THE UNIVERSITY OF MISSOURI

The University of Missouri was located at Columbia, Missouri, in 1839, and courses of instruction in Academic work began in 1841. A Department of Education was established in 1867. The College of Agriculture and Mechanic Arts and the School of Mines and Metallurgy were made Departments of the University in 1870—the School of Mines being located at Rolla. The Law Department was opened in 1872; the Medical Department in 1873; the School of Engineering in 1877. The Experiment Station was established, under act of Congress, in 1888. The Missouri State Military School was created a Department in 1890. In 1896 the Graduate Department was established.

The University has thirty buildings—twenty-three at Columbia and seven at the School of Mines at Rolla.

The School of Engineering described in this pamphlet is at Columbia.

RESOURCES

The buildings, grounds, and equipment for all departments of the University are worth nearly $2,000,000. Moreover, the endowment (interest at 5 or 6 per cent) is $1,240,-000, and the income from the United States Government (Hatch, Morrill, and Adams Acts) is nearly $45,000 a year. The income of the whole University from all sources for the year 1895 was about $510,000. These things are of vital importance, for no Engineering School that depends for its support upon tuition fees is able to meet the costly requirements of modern education.

THE SCHOOL OF ENGINEERING

It is the aim of the School of Engineering to provide a substantial foundation for the general and technical knowledge needed by the successful Engineer by giving its students thorough training in the fundamental principles which underlie all Engineering practice, with such application to problems met in the several fields of practice as may be feasible in a technical school. To this end five courses of instruction are offered, corresponding to various lines of practice and leading respectively to the degrees of Bachelor of Science (B. S.) in Civil Engineering, Electrical Engineering, Mechanical Engineering, Sanitary Engineering, and Chemical Engineering.

In each of these courses the first two years are mainly devoted to preliminary training in English, Mathematics, Physics, Chemistry, Drawing, Surveying, and Shopwork as a preparation for the more technical work of the last two years.

The course in *Civil Engineering* covers a very wide field embracing topographical, railway, hydraulic, structural, municipal, and sanitary Engineering, and it is the aim to give a broad, general training which may later serve as a foundation for the development of any ot the special lines of practice included under the general term, Civil Engineering.

The course in *Electrical Engineering* is intended to prepare students for electrical designing, manufacturing, contracting, and for the installation and management of light and power stations; in short, it is a thorough, broad, training for Electrical Engineers. The technical work consists of the theory and principles of electricity and magnetism; electrical measurements; calibration of instruments; tests of all kinds; design and construction; study of special problems in the generation, transmission, distribution, and utilization of electrical energy. Special attention is paid to alternating current phenomena.

The course in *Mechanical Engineering* is intended to fit students to enter readily any of the principal divisions of Mechanical Engineering. Training is given in the underlying principles of the profession, all work being so arranged that the application of these principles to special problems, which may arise in practice, may clearly be seen. The design of Engineering structures and machines, and the development, application, and measurement of power in its various forms are covered in the different courses.

The course in *Sanitary Engineering* is arranged with the purpose of combining a study of the principles of Sanitary Science with the fundamental training of the course in Civil Engineering.

The course in *Chemical Engineering* is offered to furnish training in Engineering together with specialization in Chemistry. In view of the development of the applications of Chemistry on a large scale in manufacturing, it is proposed to extend the course, making it more general on the Engineering side, or to offer several parallel courses as the demands may require.

REQUIREMENTS FOR ADMISSION

Fifteen (15) units are required for admission to the School of Engineering, but two (2) conditions, for the fall of 1906 alone, will be allowed. These cannot be, however, in English or Mathematics.

A unit represents the equivalent of a year's work of nine months in one subject, in a good high school, normal school or college, with five periods a week in the classroom or laboratory, each period of about forty minutes.

Three of these units *must* be in English, one and one-half in Algebra, one in Plane Geometry, two in Foreign Languages, and one in Science. The additional units required may be selected from the following list.

English—one unit.

Solid Geometry or *Plane Trigonometry*—one half unit.

Physics, *Chemistry*, *Biology*, *Zoology*, or *Botany*—one to two units.

Drawing, *Manual Training*, or *Physiography*—one unit.

History or *Latin*—one to four units.

German, *French*, *Spanish*, or *Greek*—one to three units. It is strongly recommended that students present two units in French or German to meet the requirements in Foreign Language.

In 1907-8 one-half unit in Solid Geometry will be a fixed requirement in Engineering. The courses in Engineering require that the students be strong in Mathematics and Science. Those who are not strong in these subjects are advised not to to undertake work in Engineering.

Students from Accredited Schools will not be admitted subject to a condition unless they are graduates of such schools.

ENTRANCE EXAMINATIONS AND CERTIFICATES

Examinations for admission will be held at the University 10, 11, 12, September, 1906. All persons desiring to enter during the first semester of the session of 1906-7, except those holding certificates of graduation from Accredited Schools and those who have already fulfilled the entrance requirements, must take these examinations.

The University will admit without examination such graduates of an Accredited School as bring proper credentials of the fact that they have completed the subjects required for entrance.

The diploma will not be accepted as a credential. The student must present the proper form of certificate signed by the Principal or Superintendent of the Accredited School. Blank certificates will be furnished by the Dean upon application. These certificates should be filled out and sent to the "Committee on Entrance, Columbia, Missouri."

Students who do not hold certificates of graduation from an Accredited School may present their grades in any subject. In such cases they should have the grades certified by the proper official of the school in which the grades were made.

As the necessity for correction appears in many instances, the student may avoid delay and inconvenience by sending certificates in advance of the opening of the session.

SPECIAL STUDENTS

Persons who desire to follow special lines of work, and who have not had the preliminary preparation required for admission as regular students, may be admitted as Special Students for the purpose of pursuing courses for which their preparation fits them. Such students must satisfy the Dean that they can, with profit to themselves, pursue the work selected, and they are required to maintain the same standard of excellence which is required of regular students. No special student may be a candidate for a degree unless he makes good his entrance requirements and enters in regular standing before the beginning of the senior year.

ADVANCED STANDING

Applicants for advanced standing are required to present credentials showing completion of courses equivalent to those for which they seek credit. Claims for advanced standing must be made by the student within one semester after entrance. Those who wish it may have their claims passed upon by the Dean before matriculation.

FEES AND EXPENSES

Tuition is free in all departments of the University. Students in the School of Engineering, excepting State Cadets, pay an annual entrance, library, and incidental fee of five dollars. A deposit of five dollars is required upon entrance into each laboratory course taken by the student. From this amount is deducted the fixed laboratory charge and any charges for materials or for damage to property of the University, and the remainder, if there be any, is refunded to the student at the end of the session.

The estimated cost of board and room rent in the University Dormitories for men varies from about $2.50 to about $3.50 a week. Board and lodging in private families may be had for from $3.50 to $5.00 a week. Private clubs also are formed in which the average cost is $2.50 a week. The rent of rooms is from $1.00 to $2.00 a week.

LIBRARY

The School of Engineering is equipped with an excellent working library of technical books, and with the best Engineering magazines.

The General Library of the University contains many books and pamphlets, and is open to all students of the University. Books may, under regulations, be drawn from the library.

The Library and Reading Room of the Missouri State Historical Society located in Academic Hall are open to all students of the University.

Our students have access in all to about 120,000 books and pamphlets on the campus of the University.

ENGINEERING SOCIETY

There is a flourishing Engineering Society, composed of members of the Junior and Senior classes, which affords opportunity for discussion of current Engineering topics, and brings the students and faculty together in a social way.

ATHLETICS

A new $70,000 gymnasium has just been completed. Work in physical training and athletics is thoroughly organized. The students have teams for football, basketball, track athletics, lawn tennis, and so on. There are excellent golf links, track, tennis courts, and several athletic fields.

NONRESIDENT LECTURERS

During the session lectures are delivered on Engineering subjects by prominent Engineers. This brings the students in touch with actual practice. The regular instruction requires frequent reference to current periodicals, and this, also, familiarizes the students with actual Engineering work.

LABORATORIES

During the last four years the School has been equipped with laboratories for the principal experimental work required of Engineers. The equipment is modern and adequate for all present needs.

INSTRUCTION

CIVIL ENGINEERING

F. P. Spalding, Professor; W. S. Williams, A. Lincoln Hyde, Assistant Professors; E. L. Driggs, Assistant.

This department is well equipped with instruments for teaching and surveying. There are 14 transits, 9 levels, 2 plane tables, 4 compasses, sextants, tapes, and small instruments for land topographical and railway surveys; and an 8-inch Fauth theodolite, Brandis triangulation transit, Saegmuller precise level, base apparatus, etc., for geodetic surveys.

In the laboratory for testing materials there are a Standard abrasion cylinder for paving brick, three testing machines arranged for tension, compression, and transverse tests, an Olsen torsion machine, extensometers, deflective gauges, compression micrometers, and small tools and instruments needed for tests of iron, steel, wood, brick, etc. The Cement Laboratory is fitted for all standard tests. There are Olsen and Fairbanks testing machines, mortar mixer, briquette press, apparatus for heat tests, Vicat and Gilmore needles for rate setting, appliances for fineness and specific gravity tests, glass mixing tables, and a good outfit of moulds and other small instruments.

For office work there are rolling and polar planimeters, a pantograph, topographical protractors, stadia charts, and slide rule, Thatcher calculating instrument, beam compass, etc. About 500 drawings of recent bridges, presented by Mr. T. G. Wilkerson (class of 1890) of Pittsburg, and a set of 130 drawings, carefully arranged, indexed and presented by Dr. J. A. L. Waddell, illustrating recent practice in bridge design, are available for instruction.

COURSE IN CIVIL ENGINEERING

	Hours		
Freshman Year.	*1st Sem.*	*2nd Sem.*	*No. of Course*
Algebra, Trig., and Anal. Geom.	5	5	Math. 1aA, 2aE & 1bl
Composition and Rhetoric	3	3	Chemistry 2
General Inorganic Chemistry	3	3	English 1
Mechanical Drawing	3	0	Drawing 1a
Woodwork and Forging	2	0	Shopwork 1a
Descriptive Geometry	0	3	Drawing 2b
Topographical Drawing	1	0	Drawing 5a
Elementary Surveying	0	3	C. E. 1b
Sophomore Year	*1st Sem.*	*2nd Sem.*	*No. of Course*
Calculus	5	5	Math. 4E
Higher Sur. & Ry. Location	3	3	C. E. 2a & 4b
General Physics	6	6	Physics 3
Machine Dr. & Stereotomy	2	2	Drawing 6a & 4b
Elementary Construction	2	2	C. E. 6

Junior Year	*1st Sem.*	*2nd Sem.*	*No. of Course*
Mechanics of Engineering	5	5	Mechanics 3
Railway Engineering	3	0	C. E. 5a
Spher. and Prac. Astronomy	5	2	Astronomy 5
Steam Engineering	3	0	M. E. 1a
Frame Structures	3	3	C. E. 10
Sanitary Engineering	0	2	C. E. 8b
Materials of Construction	0	2	C. E. 19b
Construction	0	2	C. E. 20b

Senior Year	*1st Sem.*	*2nd Sem.*	*No. of Course*
Hydraulic Motors	2	0	M. E. 7a
Mechanical Lab.	0	1	M. E. 11b
Geodetic Surveying	0	3	C. E. 3b
Hydraulics	2	0	C. E. 9a
Bridge Design	5	0	C. E. 11a
Theory of Structures	0	3	C. E. 12b
Masonry Structure	2	2	C. E. 13
Testing Laboratory	1	0	C. E. 14a
Specifications and Contracts	0	1	C. E. 16b
Thesis	0	2	C. E. 30b
Elective	3-6	3-6	

ELECTRICAL ENGINEERING

H. B. Shaw, Professor; A. E. Flowers, Assistant Professor; two Instructors to be appointed by 1 September.

The aim of the course is to furnish thorough training for Electrical Engineers. For this purpose the individual studies have been very carefully selected and arranged, the technical subjects being varied slightly from year to year to meet the demands of a rapidly developing profession. The first two years are devoted to preliminary training in English, Mathematics, the Sciences, and in Drawing and Shopwork. Studies 1 to 7b on the following page are given in the junior and senior years.

Instruction is given by means of recitations, lectures, and laboratory work, thoroughly correlated, the idea being to present the subject to the student as a whole, and from all points of view. A feature of considerable interest in the work is the student meetings of the American Institute of Electrical Engineers held in connection with the Seminar. The department of Physics has charge of the special course

—lectures and laboratory work—in Electrical Measurement for students in Electrical Engineering.

Attention is called to the studies, Steam Engineering, Kinematics, Hydraulic Motors, and Mechanical Laboratory under the direct charge of the department of Mechanical Engineering.

For the laboratory work in Electrical Engineering distinctively there are the following laboratories: Dynamo Laboratory for Direct and Alternating Currents; Standardizing Laboratory for the calibration of instruments; Laboratory for the testing of materials used in Electrical Construction. These Laboratories are already fairly well equipped with different types, makes and sizes of motors and generators, together with ammeters, volt-meters, and other instruments and accessories. Apparatus is being continually added as necessary. Facilities for research work are continually being improved, each student being required to present a thesis evidencing original research. As the result of such research work may be mentioned a 40,000 volt testing transformer and an oscillograph constructed by students.

COURSE IN ELECTRICAL ENGINEERING

	Hours		
Freshman Year	*1st Sem.*	*2nd Sem.*	*No. of Course*
Trig., Algebra, and Anal. Geom.	5	5	Math. 1aE, 2aE & 1b
Composition and Rhetoric	3	3	English 1
Genl. Inorganic Chemistry	3	3	Chemistry 2
Mech. Drawing and Des. Geom.	3	3	Drawing 1a and 2b
Woodwork and Forging	3	3	Shopwork 1
Sophomore Year	*1st Sem.*	*2nd Sem.*	*No. of Course*
Calculus	5	5	Math. 4E
General Physics	6	6	Physics 3
Machine Work	2	2	Shopwork 2
Elementary Surveying	2	0	C. E. 1a
Elements of Machine Drawing	0	2	Drawing 3b
Steam Eng. and Kinematics	3	3	M. E. 1a & 2b
Junior Year	*1st Sem.*	*2nd Sem.*	*No. of Course*
Mechanics of Engineering	5	5	Mechanics 3
Electrical Measurements	2	2	Physics 4
Electrical Machinery	4	4	E. E. 1
Alternating Currents	3	3	E. E. 2
Seminary	1	1	E. E. 6

Senior Year	*1st Sem.*	*2nd Sem.*	*No. of Course*
Hydraulic Motors	2	0	M. E. 7a
Mechanical Lab.	2	2	M. E. 13
Advanced Alt. Currents	3	3	E. E. 3
Electrical Design	3	3	E. E. 4
Electrical Engineering	3	3	E. E. 5
Seminary	2	2	E. E. 6
Thesis	0	2	E. E. 7b

MECHANICAL ENGINEERING

ARTHUR M. GREENE, JR., Professor; A. L. WESTCOTT, Assistant Professor; E. A. FESSENDEN, Instructor; J. R. WHARTON, Assistant.

The aim of this course is to train the student in the underlying principles of the profession so as to enable him to take up readily any special branch or Mechanical Engineering. For this purpose the design of Engineering structures and mechanics and the application, measurement and production of power are studied. Instruction is given principally by the aid of text books and laboratory work, lectures being used in a few of the courses to supplement the text books. In the class rooms advanced problems taken principally from practice are given for solution, the aim being to prepare the students for the practical work which is to come after graduation.

The department is equipped with an excellent working library which is always accessible to the student. The reading room, open at all times, is supplied with the best Enginеering magazines. The laboratory is equipped with steam, gas, and oil engines, steam turbine, water wheels, injectors, pumps, air compressors, fans, blowers, hoisting appliances, and apparatus for testing standardizing instruments. A large number of indicators, planimeters, thermometers, and water meters are used on tests, and the properties of oils, coals, transmission material, and gases are determined by apparatus for these purposes.

The work in the laboratory is to familiarize the student with the use and the care of these machines as well as with the principles underlying the design, construction, and use. In equipping the laboratory it has been the aim to select apparatus which would bring the student in contact with most of the important forms or types of machines for developing and measuring power. It is also the intention to have him make most of the tests which a Mechanical Engineer is called upon to execute, and at the same time an attempt is made to have the student make original investigations on simple problems.

COURSE IN MECHANICAL ENGINEERING

The Freshman and Sophomore years are identical with those of the course in Electrical Engineering.

Junior Year.	*Hours.* 1st Sem.	2d Sem.	*No. of Course.*
Steam Boilers	3	1	M. E. 3
Thermodynamics	0	3	M. E. 4b
Mechanical Laboratory	1	1	M. E. 11
Graphics of Machines	2	0	M. E. 14a
Electrical Machinery	4	3	E. E. 1
Mill Structures	0	2	C. E. 18b
Mechanics of Engineering	5	5	Mechanics 8

Senior Year.	*1st Sem.*	*2d Sem.*	*No. of Course.*
Heat Engines	3	0	M. E. 5a
Steam Engine Design	3	2	M. E. 6
Hyd. Motors and Pumping Mach.	2	2	M. E. 7a and 8b
Machine Design	2	2	M. E. 9
Mechanical Lab.	2	1	M. E. 12
Thesis	0	2	M. E. 19b
Alternating Currents	3	3	E. E. 2
Contracts and Specifications	0	1	C. E. 16b
Electives	0 to 3	2 to 5	

COURSE IN SANITARY ENGINEERING

The Freshman and Sophomore years are identical with those of the course in Civil Engineering.

Junior Year.	*Hours.* 1st Sem.	2d Sem.	*No. of Course.*
Mechanics of Engineering	5	5	Mech. 3
Tech. Chemistry	3	3	Chem.
General Geology	3	3	Geo. 1
Framed Structures	3	3	C. E. 10
Steam Engineering	3	0	M. E. 1a
Mechanics of Construction	0	3	C. E. 19b

Senior Year.	*1st Sem.*	*2d Sem.*	*No. of Course.*
Mechanical Laboratory	0	1	M. E. 11b
Gen. Bacteriology and Hygiene	3	3	Bact. 1a and 7b
Bridge Design	5	0	C. E. 11a
Hydraulics	2	0	C. E 9a
Specifications and Contracts	0	1	C. E. 16b
Masonry Structures	2	2	C. E. 13
Municipal Engineering	2	2	C. E. 7
Engineering Laboratory	1	0	C. E. 14a
Hyd. Motors and Pumping Mach.	2	2	M. E. 7a and 8b
Construction	0	2	C. E. 20b
Thesis	0	2	C. E. 21b

COURSE IN CHEMICAL ENGINEERING

	Hours.		
Freshman Year.	*1st Sem.*	*2d Sem.*	*No. of Course.*
Trig. and Anal. Geom.	3	5	Math. 1aE and 1bE
Composition and Rhetoric	3	3	English 1
General Inorganic Chem.	3	3	Chemistry 2
Qualitative Analysis	0	3	Chemistry 5b
Mechan. Drawing and Des. Geom.	3	3	Drawing 1a and 2b
Steam Eng. and Kinematics	3	0	M. E. 1a

Sophomore Year.	*1st Sem.*	*2d Sem.*	*No. of Course.*
General Physics	6	6	Physics 3
Calculus	5	5	Math. 4E
Organic Chemistry	3	3	Chemistry 4
Quantitative Analysis	3	0	Chemistry 6a
Kinematics	0	2	M. E. 2b

Junior Year.	*1st Sem.*	*2d Sem.*	*No. of Course.*
Mechanics of Engineering	5	5	Mechanics 3
Physical Chemistry	3	3	Chemistry 10
Thermodynamics	0	3	M. E. 4b
Electrical Machinery	4	4	E. E. 1
Elements of Machine Drawing	2	0	Drawing 3b

Senior Year.	*1st Sem.*	*2d Sem.*	*No. of Course.*
Technical Chemistry	3	3	Chemistry 10
Electrical Measurements	2	2	Physics 4
Heat Engines	3	0	M. E. 5a
Machine Design	2	2	M. E. 9
Elective (to be chosen from Chemistry, E. E. and M. E.)	5	6	
Thesis	0	2	

The degree of Civil Engineer (C. E.), Electrical Engineer (E. E.), Mechanical Engineer (M. E.), and Chemical Engineer (Ch. E.), will be conferred on candidates who, after receiving the first degree from this University, or from one of equivalent standing, have spent in the same course one year (at least ten hours a week) in graduate work in the University, or two years in professional practice and graduate work *in absentia*. The candidate must pass an examination on his graduate work and present a satisfactory thesis. The thesis subject shall be presented to the Dean on or before 1 November, and the thesis shall be presented on or before 1 May of the given year. Those who with professional practice pursue graduate work *in absentia* must be regularly enrolled as graduate students, paying the usual fees.

For a general catalogue of the University, address Merrill Otis, University Publisher, Columbia, Missouri. For further information concerning the School of Engineering, address Arthur M. Greene, Jr., Junior Dean, Columbia, Missouri.

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VOL. VIII--NO. 8 AUGUST, 1907

BULLETIN OF THE

UNIVERSITY OF MISSOURI

DEPARTMENT OF ENGINEERING

CIRCULAR OF INFORMATION

1907-1908

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THE UNIVERSITY OF MISSOURI.

The University of Missouri was located at Columbia, Missouri, in 1839, and courses of instruction in Academic work were begun in 1847. A Department of Education was established in 1867. *This was changed to a Teachers College in 1904.* The College of Agriculture and Mechanic Arts and the School of Mines and Metallurgy were made Departments of the University in 1870—the School of Mines being located at Rolla. The Law Department was opened in 1872; the Medical Department in 1873; the School of Engineering in 1877. *This was changed to the Department of Engineering in 1906.* The Experiment Station was established, under act of Congress, in 1888. The Missouri State Military School was created a Department in 1890. In 1896 the Graduate Department was established.

Columbia (population 8,000) is situated in the center of the State, half way between St. Louis and Kansas City. It is conveniently reached from the east, north, and west by the Wabash Railroad, and connecting lines. The Missouri, Kansas and Texas Railroad affords a direct route to Columbia to persons living on that line, and to those living on the Missouri Pacific, St. Louis and San Francisco, and Kansas City, Fort Scott and Memphis Railroads. The surrounding country is elevated, well drained and diversified. It is a limestone region, remarkable for its healthfulness.

The University has the following buildings: Academic Hall; separate buildings for Agriculture, Chemistry, Engineering, Geology and Zoology, Law, Mechanic Arts, and Medicine, the Parker Memorial Hospital, the Laws Observatory, the Power House, the President's house, Benton Hall and Lathrop Hall, two dormitories for men; the Gymnasium for men; the Agricultural Farm Buildings and the Live Stock Judging and Dairy building, the Horticultural building and green-houses, and Read Hall, the Dormitory for women. It has numerous laboratories and museums.

RESOURCES.

The buildings, grounds, and equipment for all Departments of the University are worth nearly $2,000,000. Moreover, the endowment (interest at five or six per cent) is $1,240,000, and the income from the United States Government (Hatch, Morrill, and Adams Acts) is nearly $45,000 a year. The income of the whole University from all sources for the year 1906 was about $500,000.

THE DEPARTMENT OF ENGINEERING.

It is the aim of the Department of Engineering to provide a substantial foundation for the general and technical knowledge needed by the successful Engineer by giving its students thorough training in the fundamental principles which underlie all Engineering practice, and in the principles of the various special branches of Engineering together with such applications in the several fields of practice as are feasible in a technical school. To this end five courses of instruction are offered, corresponding to various lines of practice, and leading respectively to the degrees of Bachelor of Science in Civil Engineering, Electrical Engineering, Mechanical Engineering, Sanitary Engineering, and Chemical Engineering.

In each of these courses the first two years are mainly devoted to training in English, Mathematics, Physics, Chemistry, Drawing, Surveying, and Shopwork as preparation for the more technical work of the last two years.

The course in *Civil Engineering* covers a wide field, embracing topographical, railway, hydraulic, structural, municipal, and sanitary Engineering, and the purpose is to give a broad, general training which may later serve as a foundation for the development of any of the special lines of practice included under the general term, Civil Engineering.

The course in *Electrical Engineering* is intended to prepare students for electrical designing, manufacturing, contracting, and for the installation and management of light and power stations; in short, it is a thorough, broad, training for Electrical Engineers. The technical work consists of the theory and principles of electricity and magnetism; electrical measurements; calibration of instruments; tests of all kinds; design and construction; study of problems in the generation, transmission, distribution, and utilization of electrical energy. Special attention is paid to alternating current phenomena.

The Course in *Mechanical Engineering* is intended to fit students to enter readily any of the principal divisions of Mechanical Engineering. Training is given in the underlying principles of the profession, all work being so arranged that the application of these principles to special problems, which may arise in practice, may clearly be seen. The design of Engineering structures and machines, and the development, application, and measurement of power in its various forms are covered in the different courses.

The course in *Sanitary Engineering* is arranged with the purpose of combining a study of the principles of Sanitation with fundamental training in Civil Engineering.

The course in *Chemical Engineering* is offered to furnish training in Engineering together with specialization in Chemistry. In view of the development of the applications of Chemistry on a large scale in manufacturing, it is proposed to extend the course, making it more general on the Engineering side, or to offer several parallel courses as the demands may require.

REQUIREMENTS FOR ADMISSION.

Fifteen (15) units are required for admission to the Department of Engineering, but two (2) conditions will be allowed in any subject accepted for entrance, excepting English, Algebra, and Plane Geometry.

A unit represents the equivalent of a year's work of nine months in one subject, in a good high school, normal school, or college, with five periods a week in the class-room or laboratory, each period of about forty minutes.

Three of these units *must* be in English, one and one-half in Algebra, one in Plane Geometry, one-half in Solid Geometry, two in foreign languages, and one in science. The additional units required may be selected from the following list.

English—one unit.

Plane Trigonometry or *Civil Government*—one-half unit.

Physics, Chemistry, Biology, Zoology, or *Botany*—one to two units.

Drawing, Manual Training, Physiography or *Agriculture*—one unit.

History or *Latin*—one to four units.

German, French, Spanish, or *Greek*—one to three units. It is strongly recommended that students present two units in French or German to meet the requirements in foreign language.

The courses in Engineering require that the students be strong in Mathematics and Science. Those who are not strong in these subjects are advised not to undertake work in Engineering.

Students from Accredited Schools will not be admitted subject to a condition unless they are graduates of such schools.

ENTRANCE EXAMINATIONS AND CERTIFICATES.

Time of Entrance Examinations:

Examinations for admission will be held at the University, September 9, 10, 11, 1907. All persons desiring to enter the University during the first semester of the session of 1907-8 except those holding certificates of graduation from Accredited Schools and those who have already otherwise fulfilled the entrance requirements, must take these examinations. *They should present themselves at the Registrar's office, room* 18, *Academic Hall, at* 8 *a. m., Monday, September* 9. They will then receive directions concerning the rooms in which the examinations will be held.

Students who enter late are required to pay additional fees and are examined or conditioned on the work already done by their classes.

The University will admit without examination such graduates of an Accredited School as bring proper credentials of the fact that they have completed the subjects required for entrance.

The *diploma* will not be accepted as a credential. The student must present the proper form of certificate signed by the Principal or Superintendent of the Accredited School. Blank certificates will be furnished by the Dean upon application. These certificates should be filled out and sent to the "Committee on Entrance, Columbia, Missouri."

Students who do not hold certificates of graduation from an Accredited School may present their grades in any subject. In such cases they should have the grades certified by the proper official of the school in which the grades were made.

As the necessity for correction appears in many instances, the student may avoid delay and inconvenience by sending certificates in advance of the opening of the session.

SPECIAL STUDENTS.

Persons who desire to follow special lines of work, and who have not had the preliminary preparation required for admission as regular students, may be admitted by the Dean under certain conditions as Special Students for the purpose of pursuing courses for which their preparation fits them. Such students must satisfy the Dean that they can, with profit to themselves, pursue the work selected, and they are required to maintain the same standard of excellence which is required of regular students. No Special Student may be a candidate for a degree unless he completes the requirements for entrance, and enters in regular standing before the beginning of the senior year.

ADVANCED STANDING.

Applicants for advanced standing are required to present credentials showing completion of courses equivalent to those for which they seek credit. Claims for advanced standing must be made by the student within one semester after entrance. Those who wish it may have their claims passed upon by the Dean before matriculation.

FEES AND EXPENSES.

Tuition is free in all Departments of the University. Students in the School of Engineering, excepting State Cadets, pay an annual entrance, library, and incidental fee of $5.00. A deposit of five dollars is required upon entrance into each laboratory course taken by the student. From this amount is deducted the fixed laboratory charge and charges for materials or for damage to property of the University, and the remainder, if there be any, is refunded to the student at the end of the session.

The estimated cost of board and room rent in the University Dormitories for men varies from about $2.50 to about $3.50 a week. Board and lodging in private families may be had for from $3.50 to $5.00 a week. Private clubs also are formed in which the average cost is $2.50 a week. The rent of rooms is from $1.00 to $3.00 a week. An estimate of expenses for the Freshman year is given below. This will also give an approximate idea of the expenses for other years.

EXPENSES, FRESHMAN YEAR, FOR MEN LIVING AT DORMITORIES.

Entrance	$ 5.00	5.00
Shop*	5.00	5.00
Chemistry*	5.00	5.00
Drawing	2.00	2.00
Surveying	5.00	5.00
Books†	15.00	20.00
Instruments†	10.00	20.00
Room	20.00	30.00
Dining Room Permit	16.00	16.00
Caution Deposit	5.00	5.00
Initiation Fee	1.00	1.00
Board	60.00	60.00
Incidental	20.00	40.00
	169.00	214.00

Note.—All fees are payable in advance.

LIBRARY.

The Department of Engineering is equipped with an excellent working library of technical books, and with the best Engineering magazines. This Department library is in the Engineering Building and is open during the day and in the evening.

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* This deposit on account of materials used usually amounts to $10.00.

†Approximate.

The General Library of the University contains many books and pamphlets, and is open to all students of the University. Books may, under regulations, be drawn from the Library.

The Library and Reading Room of the Missouri State Historical Society, located in Academic Hall, are open to all students of the University.

SOCIETIES.

There is a flourishing Engineering Society, composed of members of the Junior and Senior classes, which affords opportunity for discussion of current Engineering topics, and brings the students and faculty together in a social way. The Engineering Society publishes "The Engineering Quarterly," a periodical devoted to Engineering interests.

There are chapters of the Honorary Societies of Sigma Xi and Tau Beta Pi, to which honor students are elected. Student meetings of the American Institute of Electrical Engineers are held at regular intervals.

ATHLETICS.

A new $70,000 gymnasium has just been completed. Work in physical training and athletics is thoroughly organized. The students have teams for football, basketball, track athletics, and lawn tennis. There are excellent golf links, tracks, tennis courts, and several athletic fields.

NONRESIDENT LECTURERS.

During the session lectures are delivered on Engineering subjects by prominent Engineers. This brings the students in touch with actual practice.

LABORATORIES.

The Department is equipped with Laboratories for the principal experimental work required of Engineers. The equipment is modern and adequate for present needs. A detailed statement appears under each separate department.

INSTRUCTION.

CIVIL ENGINEERING.

F. P. SPALDING, Professor; W. S. WILLIAMS, A. LINCOLN HYDE, Wm. A. MILLER, Assistant Professors; EARL QUERBACH, Instructor; HARRY LA RUE, Assistant.

This department is well equipped with instruments for testing and surveying. There are transits, levels, plane tables, compasses, sextants, tapes, and small instruments for land, topographical and railway surveys; and an 8-inch Fauth theodolite, Brandis triangulation transit, Saegmuller precise level, base apparatus, etc., for geodetic surveys.

In the laboratory for testing materials there are: a standard abrasion cylinder for paving brick, three testing machines arranged for tension, compression and transverse tests, and Olsen torsion machine, extensometers, defective gauges, compression micrometers, and small tools and instruments needed for tests of iron, steel, wood, brick, etc. The cement laboratory is fitted for all standard tests. There are Olsen and Fairbanks testing machines, mortar mixer, briquette press, apparatus for heat tests, Vicat and Gilmore needles for rate of setting, appliances for fineness and specific gravity tests, glass mixing tables, and a good outfit of moulds and other small instruments.

For office work there are rolling and polar planimeters, a pantagraph, topographical protractors, stadia charts, and slide rule, Thatcher calculating instrument, beam compass, etc. About 500 drawings of recent bridges, presented by Mr. T. G. Wilkerson (class of 1890) of Pittsburg, and a set of 130 drawings, carefully arranged and indexed, presented by Dr. J. A. L. Waddell, illustrating recent practice in bridge design, are available for instruction.

COURSE IN CIVIL ENGINEERING.

	Credit, Hours. 1st Sem.	2d Sem.
Freshman Year.		
Algebra, Trig., and Anal. Geom.	5	5
Composition and Rhetoric	3	3
General Inorganic Chemistry	4	4
Mechanical Drawing	3	0
Descriptive Geometry	0	3
Topographical Drawing	1	0
Elementary Surveying	0	3
Woodwork and Forging	2	0
Sophomore Year.		
Calculus	5	5
General Physics	4	4
Physics Laboratory	2	2
Higher Surveying	3	0
Railway Location	0	3
Machine Drawing	0	2
Stereotomy	2	0
Elementary Construction	2	2
Junior Year.		
Mechanics of Engineering	5	5
Railway Engineering	3	0
Spher. and Prac. Astronomy	2	2
Steam Engineering	3	0
Frame Structures	3	3
Sanitary Engineering	0	2
Materials of Construction	0	2
Railway Economics	0	2
Senior Year.		
Hydraulic Motors	2	0
Mechanical Lab	0	1
Geodetic Surveying	0	3
Hydraulics	2	0
Bridge Design	5	0
Theory of Structures	0	3
Masonry Structure	0	3
Testing Laboratory	1	0
Specifications and Contracts	0	1
Principles of Economics	2	0
Thesis	0	2
Elective	3	2

ELECTRICAL ENGINEERING.

H. B. SHAW, Professor; A. E. FLOWERS, Assistant Professor;
H. B. CARPENTER, Instructor; ——————— Instructor.

To furnish thorough training for Electrical Engineers, the individual studies have been very carefully selected and arranged, the technical subjects being varied slightly from year to year to meet the demands of a rapidly developing profession.

Instruction is given by means of recitations, lectures, and laboratory work, thoroughly correlated, the idea being to present each subject to the student as a whole, and from all points of view. A feature of considerable interest in the work is the student meetings of the American Institute of Electrical Engineers held in connection with the Seminar. The department of Physics has charge of the special course—lectures and laboratory work—in Electrical Measurement for students in Electrical Engineering.

Attention is called to the studies, Steam Engineering, Kinematics, Hydraulic Motors, and Mechanical Laboratory under the direct charge of the department of Mechanical Engineering.

For the laboratory work in Electrical Engineering distinctively there are the following laboratories: Dynamo Laboratory for Direct and Alternating Currents. Standardizing Laboratory for the calibration of instruments, Laboratory for the testing of Materials used in Electrical Construction. These Laboratories are already fairly well equipped with different types, makes, and sizes of motors, and generators, together with ammeters, volt-meters, and other instruments and accessories. Apparatus is being continually added as necessary. Facilities for research work are continually being improved, each student being required to present a thesis evidencing original research. As the result of such research work may be mentioned a 40,000 volt testing transformer and an oscillograph constructed by students.

COURSE IN ELECTRICAL ENGINEERING.

	Credit, Hours.	
Freshman Year.	*1st Sem.*	*2d Sem.*
Trig., Algebra, and Anal. Geom.	5	5
Composition and Rhetoric	3	3
Genl. Inorganic Chemistry	4	4
Mech. Drawing	3	0
Descriptive Geometry	0	3
Woodwork and Forging	3	3
Sophomore Year.		
Calculus	5	5
General Physics	4	4
Physics Laboratory	2	2
Machine Shop	2	2
Elementary Surveying	2	0
Elements of Machine Drawing	0	2
Steam Engineering	3	0
Kinematics	0	3
Junior Year.		
Mechanics of Engineering	5	5
Electrical Measurements	2	2
Electrical Machinery	4	4
Alternating Currents	3	3
Seminary	1	1
Senior Year.		
Hydraulic Motors	2	0
Mechanical Lab.	2	2
Advanced Alt. Currents	3	3
Electrical Design	3	3
Electrical Engineering	3	3
Principles of Economics	2	0
Industrial Organizations	0	2
Thesis	0	2

MECHANICAL ENGINEERING.

——— ———, Professor; A. L. WESTCOTT, Assistant Professor; E. A. FESSENDEN, Instructor; J. R. WHARTON, Instructor.

This course is intended to train the student in the underlying principles of the profession so as to enable him to take up readily any special branch of Mechanical Engineering. For this purpose the design of Engineering structures and machines and the application, measurement, and production of power are studied. Instruction is given principally by the aid of text books and laboratory work, lectures being used in a few of the courses to supplement the text books. In the class rooms advanced problems taken principally from practice are given for solution, the aim being to prepare the student for the practical work which is to come after graduation.

The laboratory is equipped with steam, gas, and oil engines, steam turbine, water wheels, injectors, pumps, air compressors, fans, blowers, hoisting appliances, and apparatus for standardizing instruments. A large number of indicators, planimeters, thermometers, and water meters are used on tests, and the properties of oils, coals, transmission material, and gases are determined by apparatus for these purposes.

The work in the laboratory is to familiarize the student with the use and care of these machines as well as with the principles underlying the design, construction, and application. In equipping the laboratory it has been the aim to select apparatus which would bring the student in contact with most of the important forms or types of machines for developing and measuring power. It is also the intention to have him make most of the tests which a Mechanical Engineer is called upon to execute, and at the same time an attempt is made to have the student make original investigations on simple problems.

COURSE IN MECHANICAL ENGINEERING.

	Credit, Hours.	
Freshman Year.	*1st Sem.*	*2d Sem.*
Trig., Algebra and Anal. Geom.	5	5
Composition and Rhetoric	3	3
Gen. Inorganic Chemistry	3	3
Mech. Drawing	3	0
Descriptive Geometry	0	3
Woodwork and Forging	3	3
Sophomore Year.		
Calculus	5	5
General Physics	4	4
Physics Laboratory	2	2
Machine Shop	2	2
Elementary Surveying	2	0
Elements of Machine Drawing	0	2
Steam Engineering	3	0
Kinematics	0	3
Junior Year.		
Steam Boilers	3	1
Thermodynamics	0	3
Mechanical Laboratory	1	1
Graphics of Machines	2	0
Electrical Machinery	4	3
Mill Structures	0	2
Mechanics of Engineering	5	5
Senior Year.		
Heat Engines	3	0
Steam Engine Design	2	3
Hyd. Motors	2	0
Pumping Machinery	0	2
Machine Design	1	3
Mechanical Lab	2	1
Thesis	0	2
Alternating Currents	3	3
Contracts and Specifications	0	1
Principles of Economics	2	0

COURSE IN SANITARY ENGINEERING.

The Freshman and Sophomore years are identical with those of the course in Civil Engineering.

	Credit, Hours.	
Junior Year.	*1st Sem.*	*2d Sem.*
Mechanics and Engineering	5	5
Tech. Chemistry	3	3
Framed Structures	3	3
Steam Engineering	3	0
Materials of Construction	0	2
Sanitary Engineering	0	2
Hygiene	3	0
Senior Year.		
Mechanical Laboratory	0	1
Gen. Bacteriology	0	3
Bridge Design	5	0
Hydraulics	2	0
Specification and Contracts	0	1
Masonry Structures	0	3
Municipal Engineering	2	0
Testing Laboratory	1	0
Hyd. Motors	2	0
Pumping Machinery	0	2
General Geology	3	3
Principles of Economics	2	0
Thesis	0	2

COURSE IN CHEMICAL ENGINEERING.

	Credit, Hours.	
Freshman Year.	*1st Sem.*	*2d Sem.*
Trig. and Anal. Geom.	3	5
Composition and Rhetoric	3	3
General Inorganic Chem.	4	4
Qualitative Analysis	0	3
Mechan. Drawing and Des. Geom.	3	3
Steam Engineering	3	0
Sophomore Year.		
General Physics	6	6
Calculus	5	5
Organic Chemistry	3	3
Quantitative Analysis	3	0
Kinematics	0	3

Junior Year.

Mechanics of Engineering	5	5
Physical Chemistry	3	3
Thermodynamics	0	3
Electrical Machinery	4	4
Elements of Machine Drawing	2	0

Senior Year.

Technical Chemistry	3	3
Electrical Measurements	2	2
Heat Engines	3	0
Machine Design	2	2
Elective (to be chosen from Chemistry E. E., M. E. or Geology	5	6
Thesis	0	2

ADVANCED DEGREES.

The degree of Civil Engineer (C. E.), Electrical Engineer (E. E.), Mechanical Engineer (M. E.), and Chemical Engineer (Ch. E.), will be conferred on candidates who after receiving the Bachelor's degree from this University or one of equivalent standing, have spent in the same course one year (at least ten hours a week) in graduate work in the University, or two years in professional practice and in graduate work *in absentia*, each year the equivalent of twelve hours of University credit. The candidate must pass an examination on his graduate work and present a satisfactory thesis. The thesis subject shall be presented to the Dean on or before November 1, and the thesis shall be presented on or before May 1, of the given year. Those who with professional practice pursue graduate work *in absentia* must be regularly enrolled as graduate students, paying the usual fees.

For a general catalogue of the University, address Merrill Otis, University Publisher, Columbia, Missouri. For further information concerning the School of Engineering, address H. B. Shaw, Dean, Columbia, Missouri.

UNIVERSITY CALENDAR.

1907—September 9-12	Entrance Examinations
September 9, Monday	All Departments Open
September 12, Thursday	Opening Convocation
September 13, Friday	Class Work Begins
November 26, Tuesday, at 4 p. m., to December 2, Monday, 8 a. m.	Thanksgiving Holidays
December 20, Friday, at 4 p. m., to 1908—January 2, Thursday, at 8 a. m.	Christmas Holidays
January 20-25	Mid-Year Examinations
January 27-29	Entrance Examinations
January 27, Monday	Second Semester Begins
February 22, Saturday	Holiday
May 25-30	Final Examinations
May 30, Saturday	Stephens Medal Contest
May 31, Sunday	Baccalaureate Sermon
June 1, Monday	Class Day
June 1-3	Entrance Examinations
June 2, Tuesday	Alumni and Honor Societies' Day
June 3, Wednesday	Commencement Day

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BULLETIN OF THE

UNIVERSITY OF MISSOURI

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DEPARTMENT OF ENGINEERING

CIRCULAR OF INFORMATION

1908-1909

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THE UNIVERSITY OF MISSOURI.

The University of Missouri was located at Columbia, Missouri, in 1839, and courses of instruction in Academic work were begun in 1847. A Department of Education was established in 1867. This was changed to a Teachers College in 1904. The College of Agriculture and Mechanic Arts and the School of Mines and Metallurgy were made Departments of the University in 1870—the School of Mines being located at Rolla. The Law Department was opened in 1872; the Medical Department in 1873; the School of Engineering in 1877. This was changed to the Department of Engineering in 1906. The Experiment Station was established, under act of Congress, in 1888. The Missouri State Military School was created a Department in 1890. In 1896 the Graduate Department was established.

Columbia (population 10,000) is situated in the center of the State, half way between St. Louis and Kansas City. It is conveniently reached from the east, north, and west by the Wabash Railroad, and connecting lines. The Missouri, Kansas and Texas Railroad affords a direct route to Columbia to persons living on that line, and to those living on the Missouri Pacific, St. Louis and San Francisco, and Kansas City, Fort Scott and Memphis Railroads. The surrounding country is elevated, well drained and diversified. It is a limestone region, remarkable for its healthfulness.

The University has the following buildings: Academic Hall; separate buildings for Agriculture, Chemistry, Engineering, Geology and Zoology, Law, Mechanic Arts, and Medicine, the Parker Memorial Hospital, the Laws Observatory, the Power House, the President's house, Benton Hall and Lathrop Hall, two dormitories for men; the Gymnasium for men; the Agricultural Farm Buildings and the Live Stock Judging and Dairy building, the Horticultural building and green-houses, and Read Hall, the Dormitory for women. It has numerous laboratories and museums.

RESOURCES.

The buildings, grounds, and equipment for all Departments of the University are worth nearly $2,000,000. Moreover, the endowment (interest at five or six per cent) is $1,240,000, and the income from the United States Government (Hatch, Morrill, and Adams Acts) is nearly $45,000 a year. The income of the whole University from all sources for the year 1907 was about $650,000.

THE DEPARTMENT OF ENGINEERING.

It is the aim of the Department of Engineering to provide a substantial foundation for the general and technical knowledge needed by the successful Engineer by giving students thorough training in the fundamental principles which underlie all Engineering practice, and in the principles of the various special branches of Engineering together with such applications in the several fields of practice as are feasible in a technical school. To this end five courses of instruction are offered, leading respectively to the degrees of Bachelor of Science in Civil Engineering, Electrical Engineering, Mechanical Engineering, Sanitary Engineering, and Chemical Engineering.

In each of these courses the first two years are mainly devoted to training in English, Mathematics, Physics, Chemistry, Drawing, Surveying, and Shopwork as preparation for the more technical work of the last two years.

The course in **Civil Engineering** embraces topographical, railway, hydraulic, structural, municipal, sanitary and highway Engineering, and the purpose is to give a broad, general training which may later serve as a foundation for the development of any of the special lines of practice included under the general term, Civil Engineering.

The course in **Electrical Engineering** is intended to furnish general training for the practice of Electrical Engineering as a profession; it is a thorough, broad, training for Electrical Engineers. The technical work consists of the theory and principles of electricity and magnetism; electrical measurements; calibration of instruments; tests of all kinds; design and construction; study of problems in the generation, transmission, distribution, and utilization of electrical energy. Special attention is paid to alternating current phenomena.

The Course in **Mechanical Engineering** is intended to fit students to enter readily any of the principal divisions of Mechanical Engineering. Training is given in the underlying principles of the profession, all work being so arranged that the application of these principles to special problems, which may arise in practice, may clearly be seen. The design of Engineering structures and machines, and the development, application, and measurement of power in its various forms are covered in the different courses.

The course in **Sanitary Engineering** is arranged with the purpose of combining a study of the principles of Sanitation with fundamental training in Civil Engineering.

The course in **Chemical Engineering** is offered to furnish training in Engineering together with specialization in Chemistry.

REQUIREMENTS FOR ADMISSION.

Fifteen (15) units are required for admission to the Department of Engineering, but two (2) conditions will be allowed in any subject accepted for entrance, excepting English, Algebra, and Plane Geometry.

A unit represents the equivalent of a year's work of nine months in one subject, in a good high school, normal school, or college, with five periods a week in the class-room or laboratory, each period of about forty minutes.

Three of these units **must** be in English, one and one-half in Algebra, one in Plane Geometry, one-half in Solid Geometry, two in foreign languages, and one in science. The additional units required may be selected from the following list.

English—one unit.

Plane Trigonometry or **Civil Government**—one-half unit.

Physics, Chemistry, Biology, Zoology, or **Botany**—one to two units.

Drawing, Manual Training, Physiography or **Agriculture**—one unit.

History or **Latin**—one to four units.

German, French, Spanish, or **Greek**—one to three units. It is strongly recommended that students present two units in French or German to meet the requirements in foreign language.

The courses in Engineering require that the students be strong in Mathematics and Science. Those who are not strong in these subjects are advised not to undertake work in Engineering.

Students from Accredited Schools wil not be admitted subject to a condition unless they are graduates of such schools.

ENTRANCE EXAMINATIONS AND CERTIFICATES.

Time of Entrance Examinations:

Examinations for admission will be held at the University, September 14, 15 and 16, 1908. All persons desiring to enter the University during the first semester of the session of 1908-9 except those holding certificates of graduation from Accredited Schools and those who have already otherwise fulfilled the entrance requirements must take these examinations. **They should present** themselves at the Registrar's office, room 18, Academic Hall, at 8 a. m., Monday, September 14, to receive directions concerning the examinations.

Students who enter late are required to pay additional fees and are examined or conditioned on the work already done by their classes.

The University will admit without examination such graduates of an Accredited School as bring proper credentials of the fact that they have completed the subjects required for entrance.

The diploma will not be accepted as a credential. The student must present the proper form of certificate signed by the Principal or Superintendent of the Accredited School. Blank certificates will be furnished by the Dean upon application. These certificates should be filled out and sent to the "Committee on Entrance, Columbia, Missouri."

Students who do not hold certificates of graduation from an Accredited School may present their grades in any subject. In such cases they should have the grades certified by the proper official of the school in which the grades were made.

As the necessity for correction appears in many instances, the student may avoid delay and inconvenience by sending certificates in advance of the opening of the session.

SPECIAL STUDENTS.

Persons who desire to follow special lines of work, and who have not had the preliminary preparation required for admission as regular students, may be admitted by the Dean under certain conditions as Special Students for the purpose of pursuing courses for which their preparation fits them. Such students *must* be at least 21 years old and must satisfy the Dean, that they can, with profit to themselves, pursue the work selected, and they are required to maintain the same standard of excellence which is required of regular students. No Special Student may be a candidate for a degree unless he completes the requirements for entrance, and enters in regular standing before the beginning of the senior year.

ADVANCED STANDING.

Applicants for advanced standing are required to present credentials showing honorable dismissal and completion of courses equivalent to those for which they seek credit. Claims for advanced standing must be made by the student within one semester after entrance. Those who wish it may have their claims passed upon by the Dean before matriculation.

FEES AND EXPENSES.

Tuition is free in all Departments of the University. Students in the School of Engineering, except State Cadets, pay an annual Library and Incidental fee of $5.00. A Laboratory deposit is required for entrance into each laboratory course. This deposit covers a fixed laboratory charge and charges for material used and damage to apparatus.

The cost of board and room rent in the University Dormitories varies from $2.50 to $3.50 per week. Board and lodging elsewhere ranges from $3.50 to $5.00 a week. A careful estimate of the necessary expenses of the Freshman year for men living in University Dormitories is given in the table below:

ESTIMATE OF NECESSARY EXPENSES OF FRESHMAN YEAR FOR MEN LIVING IN UNIVERSITY DORMITORIES.

Library and Incidental Fee	$ 5 00
Laboratory Deposits:	
Shop	10 00
Chemistry	10 00
Drawing	2 00
Surveying	5 00
Books, Stationery, etc.	25 00
Drawing Instruments, etc.	20 00
Room Rent	27 00
Extra Furnishing of Room	5 00
Dining Room Permit	19 00
Dining Room Initiation Fee, University Dining Club	1 00
Caution Deposit	8 00
Board, 40 weeks	60 00
Laundry	10 00
Incidentals	25 00
	$232 00

It should be noted that all fees and deposits are payable in advance and that books, instruments, etc., have to be purchased at the beginning of the year.

LIBRARY.

The Department of Engineering is equipped with an excellent working library of technical books, and with the best Engineering magazines. This Department library is in the Engineering Building and is open during the day and in the evening.

The General Library of the University contains many books and pamphlets, and is open to all students of the University. Books may, under regulations, be drawn from the Library.

The Library and Reading Room of the Missouri State Historical Society, located in Academic Hall, are open to all students of the University.

SOCIETIES.

There is a flourishing Engineering Society, composed of members of the Junior and Senior classes, which affords opportunity for discussion of current Engineering topics, and brings the students and faculty together in a social way. The Engineering Society publishes "The Engineering Quarterly," a periodical devoted to Engineering interests.

There are chapters of the Honorary Societies of Sigma Xi and Tau Beta Pi, to which honor students are elected. A Branch of the American Institute of Electrical Engineers offers exceptional opportunities to students in Electrical Engineering.

ATHLETICS.

There is a new $70,000 gymnasium. Work in physical training and athletics is thoroughly organized. The students have teams for football, basketball, track athletics, and lawn tennis. There are excellent golf links, tracks, tennis courts, and several athletic fields.

Freshmen are required to take a course of one hour's credit in Military or in Physical Training.

NONRESIDENT LECTURERS.

During the session lectures are delivered on Engineering subjects by prominent Engineers. These lectures are especially valuable as they bring the students in touch with the commercial and practical side of actual engineering work.

LABORATORIES.

The Department is equipped with Laboratories for the principal experimental work required of Engineers. The equipment is modern and adequate for present needs.

CIVIL ENGINEERING.

F. P. SPALDING, Professor; W. S. WILLIAMS, A. LINCOLN
HYDE, Wm. A. MILLER, Assistant Professors; EARL
QUERBACH, H. W. GRAY, Instructors;
J. H. BROOKING,
Assistant.

This department is equipped with instruments for testing and surveying. There are transits, levels, plane tables, compasses, sextants, tapes, and small instruments for land, topographical and railway surveys; and an 8-inch Fauth theodolite, Brandis triangulation transit, Saegmuller precise level, base apparatus, etc., for geodetic surveys.

In the laboratory for testing materials there are: a standard abrasion cylinder for paving brick, three testing machines arranged for tension, compression and transverse tests, and Olsen torsion machine, extensometers, defective gauges, compression micrometers, and small tools and instruments needed for tests of iron, steel, wood, brick, etc. The cement laboratory is fitted for all standard tests. There are Olsen and Fairbanks testing machines, mortar mixer, briquette press, apparatus for heat tests, Vicat and Gilmore needles for rate of setting, appliances for fineness and specific gravity tests, glass mixing tables, and a good outfit of moulds and other small instruments.

For office work there are rolling and polar planimeters, a pantagraph, topographical protractors, stadia charts, and slide rule, Thatcher calculating instrument, beam compass, etc. About 500 drawings of recent bridges, presented by Mr. T. G. Wilkerson (class of 1890) of Pittsburg, and a set of 130 drawings, carefully arranged and indexed, presented by Dr. J. A. L. Waddell, illustrating recent practice in bridge design, are available for instruction.

COURSE IN CIVIL ENGINEERING.

	Credit, Hours.	
Freshman Year.	1st Sem.	2d Sem.
Algebra	2	
Trigonometry	3	
Analytical Geometry		5
Composition and Rhet.	3	3
General Inorganic Chemistry	4	4
Mechanical Drawing	3	
Descriptive Geometry		3
Topographical Drawing	1	
Elementary Surveying		3
Woodwork and Forging	2	
Sophomore Year.		
Calculus	5	5
General Physics	4	4
General Physics Laboratory	2	2
Higher Surveying	3	
Railway Surveying		3
Machine Drawing		2
Stereotomy	2	
Masonry Construction		2
Roads and Sewers	2	
Junior Year.		
Mechanics of Engineering	5	5
Railway Engineering	3	
Spherical and Practical Astronomy	2	2
Steam Engineering	2	
Framed Structures	3	3
Sanitary Engineering		2
Materials of Construction		2
Railway Economics		2
Senior Year.		
Hydraulic Machinery	2	
Mechanical Laboratory		1
Geodetic Surveying		3
Hydraulic Design		2
Bridge Design	5	
Higher Structures		3
Masonry Structures	3	
Testing Laboratory	1	
Specifications and Contracts		1
Principles of Economics	2	
Thesis		2
Elective	2	3

ELECTRICAL ENGINEERING.

H. B. SHAW, Professor; A. E. FLOWERS, Assistant Professor;
H. D. CARPENTER, M. P. WEINBACH,
and ———, Instructors.

To furnish thorough training for Electrical Engineers, the individual studies have been very carefully selected and arranged, the technical subjects being varied somewhat from year to year to meet the demands of a rapidly developing profession.

Instruction is given by means of recitations, lectures, and laboratory work, thoroughly correlated, the idea being to present each subject to the student as a whole, and from all points of view. A feature of considerable interest is a Branch of the American Institute of Electrical Engineers. The department of Physics has charge of the special course in Electrical Measurement.

Attention is called to the studies, Steam Engineering, Kinematics, Hydraulic Motors, and Mechanical Laboratory under the direct charge of the department of Mechanical Engineering.

For the laboratory work in Electrical Engineering distinctively there are the following laboratories: Dynamo Laboratory for Direct and Alternating Currents. Standardizing Laboratory for the calibration of instruments, Laboratory for the testing of Materials used in Electrical Construction. These Laboratories are equipped with different types, makes, and sizes of motors, and generators, together with ammeters, volt-meters, and other instruments and accessories. Apparatus is being continually added as necessary. Facilities for research work are continually being improved, each student being required to present a thesis evidencing original research.

COURSE IN ELECTRICAL ENGINEERING.

	Credit, Hours.	
	1st Sem.	2d. Sem.
Freshman Year.		
Algebra	2	
Trigonometry	3	
Analytical Geometry		5
Composition and Rhetoric	3	3
General Inorganic Chemistry	4	4
Mechanical Drawing	3	
Descript. Geometry		3
Woodwork and Forging	3	
Pattern Making		3
Sophomore Year.		
Calculus	5	5
General Physics	4	4
General Physics Laboratory	2	2
Machine Work	2	2
Elementary Surveying	2	
Machine Drawing		2
Steam Engineering		3
Kinematics	3	
Junior Year.		
Mechanics of Engineering	5	5
Electrical Measurements	2	2
Electrical Machinery	4	4
Alternating Currents	3	3
Seminary	1	1
Senior Year.		
Mechanical Laboratory	2	2
Advanced Alternating Currents	3	3
Electrical Design	3	3
Electrical Engineering	3	3
Principles of Economics	2	
Industrial Organizations		2
Thesis		2
Elective	2	

MECHANICAL ENGINEERING.

——— ——— Professor; E. A. FESSENDEN (in charge 1907-8),
A. L. WESTCOTT, H. S. PHILBRICK, Assistant
Professors; J. R. WHARTON,
Instructor.

This course is intended to train the student in the underlying principles of the profession so as to enable him to take up readily any special branch of Mechanical Engineering. For this purpose the design of Engineering structures and machines and the application, measurement, and production of power are studied. Instruction is given principally by the aid of text books and laboratory work, lectures being used in a few of the courses to supplement the text books. In the class rooms advanced problems taken principally from practice are given for solution, the aim being to prepare the student for the practical work which is to come after graduation.

The laboratory is equipped with steam, gas, and oil engines, steam turbine, water wheels, injectors, pumps, air compressors, fans, blowers, hoisting appliances, and apparatus for standardizing instruments. A large number of indicators, planimeters, thermometers, and water meters are used on tests, and the properties of oils, coals, transmission material, and gases are determined by apparatus for these purposes.

The work in the laboratory is to familiarize the student with the use and care of these machines as well as with the principles underlying the design, construction, and application. In equipping the laboratory it has been the aim to select apparatus which would bring the student in contact with most of the important forms or types of machines for developing and measuring power. It is also the intention to have him make most of the tests which a Mechanical Engineer is called upon to execute, and at the same time an attempt is made to have the student make original investigations on simple problems.

COURSE IN MECHANICAL ENGINEERING.

Freshman Year.	Credit, Hours.	
	1st Sem.	2d Sem.
Algebra	2	
Trigonometry	3	
Analytical Geometry		5
Composition and Rhetoric	3	3
General Inorganic Chemistry	4	4
Mechanical Drawing	3	
Descriptive Geometry		3
Woodwork and Forging	3	
Pattern Making		3
Sophomore Year.		
Calculus	5	5
General Physics	4	4
General Physics Laboratory	2	2
Machine Work	2	2
Elementary Surveying	2	
Machine Drawing		2
Steam Engineering		3
Kinematics	3	
Junior Year.		
Mechanics of Engineering	5	5
Steam Boilers		4
Thermodynamics	3	
Mechanical Laboratory	1	1
Valve Gears	2	
Electrical Machinery	4	3
Mill Structure	2	
Senior Year.		
Hydraulic Motors	2	
Heat Engines	3	
Steam Engine Design	2	3
Pumping Machinery		2
Machine Design	1	3
Alternating Currents	3	3
Specifications and Contracts		1
Mechanical Laboratory	2	1
Principles of Economics	2	
Thesis		2

SANITARY ENGINEERING.

This course is arranged with the purpose of combining a study of the principles of sanitary science with the fundamental training of the course in Civil Engineering.

The Freshman and Sophomore years are identical with those of the Course in Civil Engineering (p. 291). In the two later years, the work in structural and railway engineering is reduced and more attention is given to Sanitary Engineering. Thorough courses are arranged in those sciences which immediately underlie this particular branch, Bacteriology, Chemistry, Hygiene, and special instruction is given in building and municipal sanitation, sewage disposal, and water purification.

Junior Year.

	Credit, Hours.	
	1st Sem.	2d Sem.
Mechanics of Engineering	5	5
Technical Chemistry	3	3
Framed Structures	3	3
Steam Engineering	2	
Materials of Construction		2
Sanitary Engineering		2
General Bacteriology	3	

Senior Year.

Hydraulic Machinery	2	
Pumping Machinery		2
Mechanical Laboratory		1
Hygiene		3
Geology for Engineers		3
Principles of Economics	2	
Bridge Design	5	
Hydraulic Design		2
Specifications and Contracts		1
Masonry Structures	3	
Municipal Sanitation	2	
Testing Laboratory	1	
Thesis		2

COURSE IN CHEMICAL ENGINEERING.

In view of the development of the application of Chemistry on a large scale in manufacturing, this course is offered to furnish training in Engineering, together with specialization in Chemistry. This course will probably be revised for 1908-1909.

Freshman Year.

	Credit, Hours.	
	1st Sem.	2d Sem.
Trigonometry	3	
Analytical Geometry		5
Composition and Rhetoric	3	3
General Inorganic Chemistry	4	4
Qualitative Analysis		3
Mechanical Drawing	3	
Descriptive Geometry		3
Steam Engineering	3	

Sophomore Year.

General Physics	4	4
General Physics Laboratory	2	2
Calculus	5	5
Organic Chemistry	3	3
Quantitative Analysis	3	
Kinematics		3

Junior Year.

Mechanics of Engineering	5	5
Physical Chemistry	3	3
Thermodynamics		3
Electrical Machinery	4	4
Machine Drawing	2	

Senior Year.

Technical Chemistry	3	3
Electrical Measurements	2	2
Machine Design	1	3
Heat Engines	3	
Thesis		2
Elective to be chosen from Chemistry, E. E., M. E., and Geology	6	5

HYDRAULIC ENGINEERING.

This course is identical during the first two years with the course in Civil Engineering and leads to the same degree. During the Junior and Senior years it differs from the course in Civil Engineering in requiring less railway and structural work and devoting more attention to Hydraulic and Irrigation Engineering.

Junior Year.

	Credit, Hours.	
	1st Sem.	2d Sem.
Mechanics of Engineering	5	5
Geology for Engineers		3
Spherical and Practical Astronomy	2	2
Steam Engineering	2	
Railway Engineering	3	
Framed Structures	3	3
Sanitary Engineering		2
Materials of Construction		2

Senior Year.

Hydraulic Motors	2	
Pumping Machinery		2
Mechanical Laboratory		1
Specifications and Contracts		1
Masonry Structures	3	
Bridge Design	5	
Geodetic Surveying		3
Testing Laboratory	1	
Hydraulic Design		2
Irrigation and Drainage	2	
Rivers and Harbors		2
Principles of Economics	2	
Thesis		2
Elective		2

HIGHWAY ENGINEERING.

This course is identical during the first two years with the course in Civil Engineering and leads to the same degree. During the Junior and Senior years more time is devoted to subjects of special interest to Highway Engineers.

Junior Year.

	Credit, Hours. 1st Sem.	2d Sem.
Mechanics of Engineering	5	5
Railway Engineering	3	
Railway Economics		2
Steam Engineering	2	
Framed Structures	3	3
Materials of Construction		2
Organic Chemistry	3	
Geology for Engineers		3

Senior Year.

	1st Sem.	2d Sem.
Hydraulic Motors	2	
Mechanical Laboratory	1	
Hydraulic Design	2	
Bridge Design	5	
Masonry Structures	3	
Sanitary Engineering		2
Testing Laboratory	1	
Specifications and Contracts		1
Principles of Economics	2	
Economics of Transportation		2
Testing Road Materials		1
Highway Structures		2
Country Roads		2
City Pavements	2	
Thesis		2

ADVANCED DEGREES.

The degree of Civil Engineer (C. E.), Electrical Engineer (E. E.), Mechanical Engineer (M. E.), and Chemical Engineer (Ch. E.), will be conferred on candidates who after receiving the Bachelor's degree from this University or one of equivalent standing, have spent in the same course one year (at least ten hours a week) in graduate work in the University, or two years in professional practice and in graduate work *in absentia*, each year the equivalent of twelve hours of University credit. The candidate must pass examinations on his graduate work and present a satisfactory thesis. The thesis subject shall be presented to the Dean on or before November 1, and the thesis shall be presented on or before May 1, of the given year. Those who with professional practice pursue graduate work *in absentia*, must be regularly enrolled as graduate students, paying the usual fees.

For a general catalogue of the University, address Merrill Otis, University Publisher, Columbia, Missouri. For further information concerning the School of Engineering, address H. B. Shaw, Dean, Columbia, Missouri.

UNIVERSITY CALENDAR.

1908—September 14-16	Entrance Examinations
September 14, Monday	All Departments Open
September 17, Thursday	Opening Convocation
September 18, Friday	Class Work Begins
November 25, Wednesday, at 4 p. m. to November 30, Monday, at 8 a. m.	Thanksgiving Holidays
December 8, Tuesday	Semi-Annual Meeting of Curators
December 23, Wednesday, at 4 p. m. to 1909—January 5, Tuesday, at 8 a. m.	Christmas Holidays
January 25-30	Mid Year Examinations
February 1-3	Entrance Examinations
February 1, Monday	Second Semester Begins
February 22, Monday	Holiday
April 1, Thursday	Quarterly Meeting of Curators
May 24-29	Final Examinations
May 29, Saturday	Stephens Medal Contest
May 30, Sunday	Baccalaureate Sermon
May 31, Monday	Class Day
May 31 to June 1	Entrance Examinations
June 1, Tuesday	Alumni and Phi Beta Kappa Day
June 2, Wednesday	Annual Meeting of Curators
June 2, Wednesday	Commencement Day

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JULY, 1909

Bulletin of the University of Missouri

ANNOUNCEMENT
OF THE
SCHOOL OF ENGINEERING

1909-1910

COLUMBIA, MISSOURI

Session Begins September 20, 1909

PUBLISHED BY
The University of Missouri
ISSUED MONTHLY

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THE UNIVERSITY OF MISSOURI.

The University of Missouri was located at Columbia, Missouri, in 1839, and courses of instruction in Academic work were begun in 1841. A Department of Education was established in 1867. This was changed to a Teachers College in 1904. The College of Agriculture and Mechanic Arts and the School of Mines and Metallurgy were made Departments of the University in 1870—the School of Mines and Metallurgy being located at Rolla. The Law Department was opened in 1872; the Medical Department in 1873; the School of Engineering in 1877. The Experiment Station was established, under act of Congress, in 1888. The Missouri State Military School was created a Department in 1890. In 1896 the Graduate Department was established, and the School of Journalism in 1908.

Columbia, a town of about 10,000 inhabitants, is situated near the center of the State, half way between St. Louis and Kansas City. It is conveniently reached from the east, north, and west by the Wabash Railroad, and connecting lines. The Missouri, Kansas and Texas Railroad affords a direct route to Columbia to persons living on that line, and to those living on the Missouri Pacific, St. Louis and San Francisco, and other southern railroads.

The surrounding country is elevated, well drained and diversified. It is a limestone region, remarkable for its healthfulness. The University campus includes 32 acres of undulating ground in the southern part of the town. The Experiment Farm lies one square south of the Campus, and comprises 648 acres. The Horticultural Grounds (a part of the Farm) are one square east of the Campus and include about 30 acres.

The University has the following buildings at Columbia: Academic Hall; separate buildings for Agriculture, Chemistry, Engineering, Geology and Zoology, Law, Mechanic Arts, and Medicine, the Parker Memorial Hospital, the Laws Observatory, the Power House, the President's House, Benton Hall and Lathrop Hall, two dormitories for men; the gymnasium for men; the Agricultural Farm Buildings, the Live Stock Judging and Dairy Buildings, the Horticultural building and green-houses, and Read Hall, the Dormitory for women. The Gymnasium for women is located in Academic Hall.

THE SCHOOL OF ENGINEERING.

It is the aim of the School of Engineering to provide a substantial foundation for the general and technical knowledge needed by the successful Engineer by giving students thorough training in the fundamental principles which underlie all Engineering practice, and in the principles of the various special branches of Engineering together with such applications in the several fields of practice as are feasible in a technical school. To this end four undergraduate curricula are offered, leading to the degrees of Bachelor of Science in Civil Engineering, Electrical Engineering, Mechanical Engineering, Sanitary Engineering, and Chemical Engineering. These degrees will not be granted after the session of 1914-15, and students will not be admitted to the curricula leading to these degrees after June, 1911. In each of these curricula the first two years are mainly devoted to training in English, Mathematics, Physics, Chemistry, Drawing, Surveying, and Shopwork as preparation for the more technical work of the last two years.

Beginning September, 1909, professional curricula will be offered leading to the degrees of Civil Engineer, Electrical Engineer, Mechanical Engineer, and Chemical Engineer.

The curricula in **Civil Engineering** embrace topographical, railway, hydraulic, structural, municipal, sanitary and highway Engineering, and the purpose is to give a broad, general training which may later serve as a foundation for the development of any of the special lines of practice included under the general term, Civil Engineering.

The curricula in **Electrical Engineering** are intended to furnish general training for the practice of Electrical Engineering as **a profession**, that is a thorough, broad, training for Electrical Engineers. The technical work consists of the theory and principles of electricity and magnetism; electrical measurements; calibration of instruments; tests of all kinds; design and construction; study of problems in the generation, transmission, distribution, and utilization of electrical energy. Special attention is paid to alternating current phenomena.

The curricula in **Mechanical Engineering** are intended to fit students to enter readily any of the principal divisions of Mechanical Engineering. Training is given in the underlying principles of the profession, all work being so arranged that the application of these principles to special problems, which may arise in practice, may clearly be seen. The design of Engineering structures and machines, and the development, application, and measurement of power in its various forms are covered in the different courses.

The curricula in **Chemical Engineering** are offered to furnish training in Engineering together with specialization in Chemistry.

REQUIREMENTS FOR ADMISSION.

Fifteen (15) units are required for admission to the undergraduate curricula in the School of Engineering, but two (2) conditions will be allowed in any subject accepted for entrance, excepting English, Algebra, and Plane Geometry. Any such conditions must be removed within a year.

A unit represents the equivalent of a year's work of nine months in one subject, in a good high school, normal school, or college, with five periods a week in the class-room or laboratory, each period of about forty minutes.

Three of these units **must** be in English, one and one-half in Algebra, one in Plane Geometry, one-half in Solid Geometry, two in foreign languages, and one in science. The additional units required may be selected from the following list:

English—one unit.

Plane Trigonometry or **Civil Government**—one-half unit.

Physics, Chemistry, Biology, Zoology, or **Botany**—one to two units.

Drawing, Manual Training, Physiography or **Agriculture**—one unit.

History or **Latin**—one to four units.

German, French, Spanish, or **Greek**—one to three units. It is strongly recommended that students present two units in French or German to meet the requirements in foreign language.

The courses in Engineering require that the students be strong in Mathematics and Science. Those who are not strong in these subjects are advised not to undertake work in Engineering.

Students from Accredited Schools will not be admitted subject to a condition unless they are graduates of such schools.

Admission to the new three year professional curricula requires the equivalent of two years (60 hours credit) in the College of Arts and Science.

ENTRANCE EXAMINATIONS AND CERTIFICATES.

Time of Entrance Examinations:

Examinations for admission will be held at the University, September 20, 21, and 22, 1909. All persons desiring to enter the University during the first semester of the session of 1909-10 except those holding certificates of graduation from Accredited Schools and those who have already otherwise fulfilled the entrance requirements must take these examinations. **They should present themselves at the Registrar's office, room 18, Academic Hall, at 8 a. m., Monday, September 20,** to receive directions concerning the examinations.

Students who enter late are required to pay additional fees and are examined or conditioned on the work already done by their classes.

The University will admit without examination such graduates of an Accredited School as bring proper credentials of the fact that they have completed the subjects required for entrance.

The **diploma** will not be accepted as a credential. The student must present the proper form of certificate signed by the Principal or Superintendent of the Accredited School. Blank certificates will be furnished by the Dean upon application. These certificates should be filled out and sent to the Committee on Entrance, Columbia, Missouri.

Students who do not hold certificates of graduation from an Accredited School may present their grades in any subject. In such cases they should have the grades certified by the proper official of the school in which the grades were made.

As the necessity for correction appears in many instances, the student may avoid delay and inconvenience by sending certificates in advance of the opening of the session.

SPECIAL STUDENTS.

Persons who desire to follow special lines of work, and who have not had the preliminary preparation required for admission as regular students, may be admitted by the Dean under certain conditions as Special Students for the purpose of pursuing courses for which their preparation fits them. Such students *must* be at least 21 years old and must satisfy the Dean, that they can, with profit to themselves, pursue the work selected, and they are required to maintain the same standard of excellence which is required of regular students. No Special Student may be a candidate for a degree unless he completes the requirements for entrance, and enters in regular standing before the beginning of the senior year.

ADVANCED STANDING.

Applicants for advanced standing are required to present credentials showing honorable dismissal and completion of courses equivalent to those for which they seek credit. Claims for advanced standing must be made by the student within one semester after entrance. Those who wish it may have their claims passed upon by the Dean before matriculation.

FEES AND EXPENSES.

Tuition is $10 a semester in the School of Engineering. Students in the School of Engineering pay an annual Library and Incidental fee of $10. A Laboratory deposit is required for each laboratory course. This deposit covers a fixed laboratory charge and charges for material used and damage to apparatus.

The cost of board and room rent in the University Dormitories varies from $2.50 to $3.50 per week. Board and lodging elsewhere ranges from $3.50 to $5.00 a week. A careful estimate of the necessary expenses of the Freshman year for men living in University Dormitories is given in the table below:

ESTIMATE OF NECESSARY EXPENSES OF FRESHMAN YEAR FOR MEN LIVING IN UNIVERSITY DORMITORIES.

Library and Incidental Fee	$ 10 00
Tuition	20 00
Laboratory Deposits:	
Shop	10 00
Chemistry	10 00
Drawing	2 00
Surveying	5 00
Room Rent	27 00
Extra Furnishing of Room	5 00
Dining Room Permit	19 00
Dining Room Initiation Fee	1 00
Caution Deposit	8 00
Board, 40 Weeks	60 00
Books, Stationery, Etc.	25 00
Drawing Instruments and Material	20 00
Laundry	10 00
Incidentals	25 00
	$257.00

Fees and deposits are payable in advance, and books, instruments, etc., have to be purchased at the beginning of the year.

LIBRARY.

The School of Engineering is equipped with an excellent working library of technical books, and with the best Engineering magazines. This Department library is in the Engineering Building and is open during the day and in the evening.

The General Library of the University contains many books and pamphlets, and is open to all students of the University. Books may, under regulations, be drawn from the Library.

The Library and Reading Room of the Missouri State Historical Society, located in Academic Hall, are open to all students of the University.

SOCIETIES.

There is a flourishing Engineering Society, composed of members of the Junior and Senior classes, which affords opportunity for discussion of current Engineering topics, and brings the students and faculty together in a social way. The Engineering Society publishes The Engineering Quarterly, a periodical devoted to Engineering interests.

There are chapters of the Honorary Societies of Sigma Xi and Tau Beta Pi, to which honor students are elected. A Branch of the American Institute of Electrical Engineers offers exceptional opportunities to students in Electrical Engineering, and a Club of Mechanical Engineers for the discussion of technical subjects.

ATHLETICS.

There is an excellent gymnasium, golf links, tracks, tennis courts, and athletic fields. Work in physical training and athletics is thoroughly organized. The students have teams for football, basketball, track athletics and tennis.

Freshmen are required to take a course of one hour's credit in Military or in Physical Training.

NONRESIDENT LECTURERS.

During the session lectures are delivered on Engineering subjects by prominent Engineers. These lectures are especially valuble as they bring the students in touch with the commercial and practical side of actual engineering work.

LABORATORIES.

The Department is equipped with Laboratories for the principal experimental work required of Engineers. The equipment is modern and great care has been taken in the selection of apparatus.

CIVIL ENGINEERING.

F. P. SPALDING, Professor; W. S. WILLIAMS, A. LINCOLN HYDE, Wm. A. MILLER, Assistant Professors; EARL QUERBACH, H. W. GRAY, Instructors; J. H. BROOKING, Assistant.

This department is equipped with instruments for testing and surveying. There are transits, levels, plane tables, compasses, sextants, tapes, and small instruments for land, topographical and railway surveys; and an 8-inch Fauth theodolite, Brandis triangulation transit, Saegmuller precise level, base apparatus, etc., for geodetic surveys.

In the laboratory for testing materials there are: a standard abrasion cylinder for paving brick, three testing machines arranged for tension, compression and transverse tests, and Olsen torsion machine, extensometers, gauges, compression micrometers, and small tools and instruments needed for tests of iron, steel, wood, brick, etc. The cement laboratory is fitted for all standard tests. There are Olsen and Fairbanks testing machines, mortar mixer, briquette press, apparatus for heat tests, Vicat and Gilmore needles for rate of setting, appliances for fineness and specific gravity tests, glass mixing tables, and a good outfit of moulds and other small instruments.

For office work there are rolling and polar planimeters, a pantagraph, topographical protractors, stadia charts, and slide rule, Thatcher calculating instrument, beam compass, etc. About 500 drawings of recent bridges, presented by Mr. T. G. Wilkerson (class of 1890) of Pittsburg, and a set of 130 drawings, carefully arranged and indexed, presented by Dr. J. A. L. Waddell, illustrating recent practice in bridge design, are available for instruction.

FOUR YEAR CURRICULUM LEADING TO THE DEGREE OF BACHELOR OF SCIENCE IN CIVIL ENGINEERING.

	Credit, Hours. 1st Sem.	Credit, Hours. 2d Sem.
Freshman Year.		
Algebra and Trigonometry	5	0
Analytical Geometry	0	5
Composition and Rhetoric	0	5
General Inorganic Chemistry	3	3
Mechanical Drawing	5	0
Topographic Drawing	1	0
Wood Work and Forging	1	0
Elementary Surveying	0	2
Sophomore Year.		
Differential Calculus	4	0
Integral Calculus	0	5
General Physics	5	5
Principles of Economics	2	0
Descriptive Geometry	0	2
Higher Surveying	3	0
Railway Surveying	0	4
Roads and Sewers	2	0
Junior Year.		
Mechanics of Engineering	4	4
Spher. and Prac. Astronomy	2	2
Engines and Boilers	2	0
Railway Engineering	4	0
Framed Structures	3	3
Masonry Structures	0	4
Materials of Construction	0	2
Senior Year.		
M. E. Laboratory	0	1
Geodetic Surveying	0	3
Bridge Design	5	0
Concrete Structures	2	0
Testing Laboratory	1	0
Hydraulic Machinery	2	0
Hydraulic Design	0	2
Sanitary Engineering	2	0
Specifications and Contracts	0	1
Thesis	0	2

Elective—At least 8 hours' credit in subjects to be chosen from:

General Subject.	No. of Course.	Special Title.	Hours credit.
Civil Engineering	14a	Railway Maintenance	3
Civil Engineering	15b	Railway Yards and Terminals	2
Civil Engineering	23b	Higher Structures	3
Civil Engineering	24b	Mill Structures	2
Civil Engineering	43a	Irrigation and Drainage	2
Civil Engineering	44b	Rivers and Harbors	2
Civil Engineering	53b	Municipal Sanitation	3
Civil Engineering	54a	Country Roads	2
Civil Engineering	55b	City Pavements	2
Civil Engineering	56b	Highway Structures	2
Civil Engineering	34b	Testing Road Materials	1
Geology			3
Economics			2
Astronomy			3

THREE YEAR CURRICULUM LEADING TO THE DEGREE OF CIVIL ENGINEER.

For entrance upon this curriculum two years of college work (equivalent to 60 hours' credit in the College of Arts and Science of this University) are required.

The completion of 90 hours' work is required, including the following subjects:

General Subject.	No. of Course.	Special Title.	Hours credit.
Drawing	1a or 1b	Mechanical Drawing	5
Drawing	2a or 2b	Descriptive Geometry	2
Drawing	4a	Mechanics of Engineering	8
Mechanics	3	Topographical Drawing	1
Geology	6a or 6b	Geology for Engineers	3
Astronomy	3	Spher. and Prac. Astronomy	4
Mechanical Engineering	31a	Engines anl Boilers	2
Mechanical Engineering	24b	M. E. Laboratory	1
Civil Engineering	1a or 2b	Elementary Surveying	2
Civil Engineering	4a	Higher Surveying	3
Civil Engineering	5b	Geodetic Surveying	3
Civil Engineering	11b	Railway Surveying	4
Civil Engineering	12b	Railway Engineering	4
Civil Engineering	21	Framed Structure	6
Civil Engineering	22a	Bridge Design	5
Civil Engineering	23b	Higher Structures	3
Civil Engineering	25b	Masonry Structures	4
Civil Engineering	26a	Concrete Structures	2
Civil Engineering	32b	Materials of Construction	2
Civil Engineering	33a	Testing Laboratory	1
Civil Engineering	41a	Hydraulic Machinery	2
Civil Engineering	42b	Hydraulic Design	2
Civil Engineering	51a	Roads and Sewers	2
Civil Engineering	52a	Sanitary Engineering	2
Civil Engineering	61b	Specific. and Contracts	1
Civil Engineering	100b	Thesis	2
Elective			14

ELECTRICAL ENGINEERING.

H. B. SHAW, Professor; A. E. FLOWERS, Assistant Professor;
H. D. CARPENTER, M. P. WEINBACH,
Instructors.

To furnish thorough training for Electrical Engineers, the individual studies have been very carefully selected and arranged, the technical subjects being varied somewhat from year to year to meet the demands of a rapidly developing profession.

Instruction is given by means of recitations, lectures, and laboratory work, thoroughly correlated, the idea being to present each subject to the student as a whole, and from all points of view. A feature of considerable interest is a Branch of the American Institute of Electrical Engineers. The department of Physics has charge of the special course in Electrical Measurement.

Attention is called to the studies, Steam Engineering, Kinematics, Hydraulic Motors, and Mechanical Laboratory under the direct charge of the department of Mechanical Engineering.

For the laboratory work in Electrical Engineering distinctively there are the following laboratories: Dynamo Laboratory for Direct and Alternating Currents. Standardizing Laboratory for the calibration of instruments, Laboratory for the testing of Materials used in Electrical Construction. These Laboratories are equipped with different types, makes, and sizes of motors, and generators, together with ammeters, volt-meters, and other instruments and accessories. Facilities for research work are continually being improved, each student being required to present a thesis evidencing original work.

FOUR YEAR CURRICULUM LEADING TO THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING.

(Fifteen units of High School work required for entrance.)

	Credit, Hours.	
	1st Sem.	2d Sem.
Freshman Year.		
Algebra and Trigonometry	5	0
Analytical Geometry	0	5
Composition and Rhetoric	5	0
Mechanical Drawing	0	5
General Inorganic Chemistry	3	3
Woodwork and Forging	2	0
Pattern Making	0	2
Sophomore Year.		
Differential Calculus	4	0
Integral Calculus	0	4
Principles of Economics	0	4
General Physics	5	5
Machine Work	2	2
Descriptive Geometry	2	0
Elementary Surveying	2	0
Junior Year.		
Mechanics of Engineering	4	4
Electrical Machinery	4	4
Electrical Measurements	5	0
Elementary Alternating Currents	0	5
Seminary	1	1
Senior Year.		
Prime Movers	3	3
Mechanical Laboratory	1	1
Adv. Alternating Currents	5	0
Electrical Design	3	3
Electrical Engineering	3	3
Thesis	0	2
Elective	0	3

THREE YEAR CURRICULUM LEADING TO THE DEGREE OF ELECTRICAL ENGINEER.

For entrance upon this Curriculum, two years of college work, the equivalent of 60 hours' credit in the College of Arts and Science, is required.

The completion of 90 hours' credit is required, including the following courses:

General Subject.	No. of Course.	Special Title.	Hours credit.
Drawing	1	Mechanical Drawing	5
Drawing	2	Descriptive Geometry	2
Shopwork	1	Woodwork and Forging	2
Shopwork	2	Pattern Making	2
Shopwork	3	Machine Work	4
Civil Engineering	1	Elementary Surveying	2
Mechanics	3	Mechanics of Engineering	8
Physics	4	Electrical Measurements	5
Mechanical Engineering	33	Prime Movers	6
Mechanical Engineering	23	Mechanical Laboratory	2
Electrical Engineering	1	Electrical Machinery	8
Electrical Engineering	2	Elementary Alternating Currents	5
Electrical Engineering	3	Advanced Alternating Currents.	5
Electrical Engineering	4	Electrical Design	6
Electrical Engineering	5	Electrical Engineering	6
Electrical Engineering	6	Seminary	2
Electrical Engineering	7b	Thesis	2

MECHANICAL ENGINEERING.

H. W. HIBBARD, Professor; E. A. FESSENDEN, A. L. WESTCOTT, H. S. PHILBRICK, Assistant Professors;
J. R. WHARTON, Instructor.

The study of the Science of Machinery is intended to fit young men to secure the greatest advantage from the practical experience which must precede, accompany or follow this study, and to enable them to be of earlier and greater responsible value in connection with Engineering Properties, as designers, in testing and inspection work, in engineering salesmanship or other associated specialties, in power plant operation, in manufacturing and industrial management, and in improvement of existing or in creation of new properties.

The laboratory is equipped with steam, gas, and oil engines, steam turbine, water wheels, injectors, pumps, air compressors, fans, blowers, hoisting appliances, and apparatus for standardizing instruments. A large number of indicators, planimeters, thermometers, and water meters are used on tests, and the properties of oils, coals, transmission material, and gases are determined by apparatus for these purposes.

The work in the laboratory is to familiarize the student with the use and care of these machines as well as with the principles underlying the design, construction, and application. In equipping the laboratory it has been the aim to select apparatus which would bring the student in contact with most of the important forms or types of machines for developing and measuring power. It is also the intention to have him make most of the tests which a Mechanical Engineer is called upon to execute, and at the same time an attempt is made to have the student make original investigations on simple problems.

FOUR YEAR CURRICULUM LEADING TO THE DEGREE OF BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING.

(Fifteen (15) units of High School work required for entrance.)

Freshman Year.

	Credit, Hours.	
	1st Sem.	2d Sem.
Algebra and Trigonometry	5	0
Analytical Geometry	0	5
Composition and Rhetoric	5	0
General Inorganic Chemistry	3	3
Mechanical Drawing	0	5
Woodwork and Forging	2	0
Pattern Making	0	2

Sophomore Year.

Differential Calculus	4	0
Integral Calculus	0	4
General Physics	5	5
Descriptive Geometry	2	0
Principes of Economics	0	2
Machine Work	2	2
Elementary Surveying	2	0
Elementary Mechanisms	0	2

Junior Year.

Mechanics of Engineering	4	4
Electrical Machinery	4	3
Engineering Materials	2	0
Machine Design	0	3
Steam Machinery	3	3
Elementary Mechanical Lab.	2	2

Senior Year.

Heat Engines	3	0
Steam Turbines	2	0
Gas Engines	0	2
Steam Engineering	3	5
Advanced Machine Design	3	0
Mill Structures	0	2
Advanced Mechanical Laboratory	2	2
Specifications and Contracts	0	1
Handling of Men	0	1
Elective	2	0
Thesis	0	2

THREE YEAR CURRICULUM LEADING TO THE DEGREE OF MECHANICAL ENGINEER.

For entrance to this curriculum two years of college work (equivalent to 60 hours' credit in the College of Arts and Science in this University) are required.

The completion of 90 hours' work is required, including the following subjects:

General Subject.	No. of Course.	Special Title.	Hours credit.
Drawing	1a or 1b	Mechanical Drawing	5
Drawing	2a or 2b	Descriptive Geometry	2
Shopwork	1a	Woodwork and Forging	2
Shopwork	2b	Pattern Making	2
Shopwork	3	Machine Work	4
Civil Engineering	1a	Elementary Surveying	2
Mechanics	3	Mechanics of Engineering	8
Electrical Engineering	1	Electrical Machinery	7
Civil Engineering	24b	Mill Structures	2
Civil Engineering	61b	Specifications and Contracts	1
Mechanical Engineering	1b	Elementary Mechanisms	2
Mechanical Engineering	2a	Engineering Materials	2
Mechanical Engineering	3b	Machine Design	3
Mechanical Engineering	4a	Advanced Machine Design	3
Mechanical Engineering	21	Elementary Mechanical Lab.	4
Mechanical Engineering	22	Advanced Mechanical Lab.	4
Mechanical Engineering	32	Steam Machinery	6
Mechanical Engineering	35a	Heat Engines	3
Mechanical Engineering	36a	Steam Turbines	2
Mechanical Engineering	37b	Gas Engines	2
Mechanical Engineering	39	Steam Engineering	8
Mechanical Engineering	12b	Handling of Men	1
Mechanical Engineering	62b	Thesis	2
		Elective	13
			90

CHEMICAL ENGINEERING.

In view of the development of the application of Chemistry on a large scale in manufacturing, curricula are offered to furnish training in Engineering, together with specialization in Chemistry.

FOUR YEAR CURRICULUM LEADING TO THE DEGREE OF BACHELOR OF SCIENCE IN CHEMICAL ENGINEERING.

(Fifteen units of High School credits required for entrance.)

	Credit, Hours.	
Freshman Year.	1st Sem.	2d Sem.
Algebra and Trigonometry	5	0
Analytical Geometry	0	5
Composition and Rhetoric	0	5
Mechanical Drawing	5	0
General Inorganic Chemistry	3	3
Qualitative Analysis	2	3
Sophomore Year.		
Differential Calculus	4	0
Integral Calculus	0	4
General Physics	5	5
Organic Chemistry	3	3
Descriptive Geometry	0	2
Elementary Mechanisms	0	2
Quantitative Analysis	3	0
Junior Year.		
Mechanics of Engineering	4	4
Physical Chemistry	3	3
Electrical Machinery	4	4
Prime Movers	3	3
Mechanical Laboratory	1	1
Senior Year.		
Technical Chemistry	3	3
Electrical Measurements	5	0
Machine Design	0	3
Principles of Economics	2	0
Thesis	0	2
Elective	4	6

THREE YEAR CURRICULUM LEADING TO THE DEGREE OF CHEMICAL ENGINEER.

For entrance to this curriculum two years of college work, the equivalent of 60 hours' credit in the College of Arts and Science is required.

The completion of 90 hours' credit is required, including the following courses :

General Subject.	No. of Course.	Special Title.	Hours credit.
Drawing	1	Mechanical Drawing	5
Drawing	2	Descriptive Geometry	2
Mechanical Engineering	1	Elementary Mechanisms	2
Mechanics, Electrical	3	Mechanics of Engineering	8
Electrical Engineering	1	Electrical Machinery	8
Mechanical Engineering	33	Prime Movers	6
Mechanical Engineering	23	Mechanical Laboratory	2
Physics	4	Electrical Measurements	5
Mechanical Engineering		Elementary Machinery Design	3
Chemistry	7	Qualitative Analysis	5
Chemistry	11	Organic Chemistry	6
Chemistry	21	Quantitative Analysis	3
Chemistry	18	Physical Chemistry	6
Chemistry	10	Technical Chemistry	6
Chemistry	14a or 14b	Industrial Chemistry	3
		Thesis	2

Students who have been granted bachelor's degrees in Engineering by this University or by one of equivalent standing, will be admitted as graduate students in Engineering and to candidacy for the degrees of Civil Engineer (C. E.), Electrical Engineer (E. E.), Mechanical Engineer (M. E.), and Chemical Engineer (Ch. E.). The normal requirements for these degrees are credits for one full year of graduate work in residence and an acceptable thesis.

No new students will hereafter be admitted to graduate work in absentia.

All graduate students must be regularly admitted, paying the usual fees.

The thesis subject shall be presented to the Dean of the School of Engineering on or before December 1, and the thesis itself on or before May 1 of the given year. The graduate work is under the direct charge of the heads of the respective departments.

For a general catalogue of the University, address the University Publisher, Columbia, Missouri. For further information concerning the School of Engineering, address H. B. Shaw, Dean, Columbia, Missouri.

UNIVERSITY CALENDAR.

1909—May 24-29	Final Examinations
May 29, Saturday	Stephens Medal Contest
May 30, Sunday	Baccalaureate Sermon
May 31, Monday	Class Day
June 1, Tuesday	Alumni and Phi Beta Kappa Day
June 2, Wednesday	Commencement Day
June 3, Thursday	Summer Session Begins
August 3, Tuesday	Summer Session Closes
September 20-22	**Entrance Examinations**
September 20, Monday	**All Departments Open**
November 24, Wednesday, 12 m., to November 29, Monday, 8 a. m.	Thanksgiving Holidays
December 22, Wednesday, at 4 p. m., to 1910—January 4, Tuesday, at 8 a. m.	Christmas Holidays
January 31-February 5	**Mid-Year Examinations**
February 7, Monday	**Second Semester Begins**
May 30-June 4	Final Examinations
June 5, Sunday	Baccalaureate Sermon
June 6, Monday	Class Day
June 7, Tuesday	Alumni and Phi Beta Kappa Day
June 9, Thursday	**Commencement Day**

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Bulletin of the University of Missouri

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The University of Missouri was located at Columbia, Missouri in 1839, and courses of instruction in Academic work were begun in 1841. A Department of Education was established in 1867. This was changed to a Teachers College in 1904. The College of Agriculture and Mechanic Arts and the School of Mines and Metallurgy were made Departments of the University in 1870—the School of Mines and Metallurgy being located at Rolla. The Law Department was opened in 1872; the Medical Department in 1873; the School of Engineering in 1877. The Experiment Station was established, under act of Congress, in 1888. The Missouri State Military School was created a Department in 1890. In 1896 the Graduate Department was established, and the School of Journalism in 1908.

Columbia, a town of about 10,000 inhabitants, is situated near the center of the State, half way between St. Louis and Kansas City. It is conveniently reached from the east, north, and west by the Wabash Railroad, and connecting lines. The Missouri, Kansas and Texas Railroad affords a direct route to Columbia to persons living on that line, and to those living on the Missouri Pacific, St. Louis and San Francisco, and other southern railroads.

The surrounding country is elevated, well drained and diversified. It is a limestone region, remarkable for its healthfulness. The University campus includes 32 acres of undulating ground in the southern part of the town. The Experiment Farm lies one square south of the Campus, and comprises 648 acres. The Horticultural Grounds are one square east of the Campus and include about 30 acres.

The University has the following buildings at Columbia: Academic Hall; separate buildings for Agriculture, Chemistry, Engineering, Geology and Zoology, Law, Mechanic Arts, and Medicine, the Parker Memorial Hospital, the Laws Observatory, the Power House, the President's House, Benton Hall and Lathrop Hall, two dormitories for men; the gymnasium for men; the Agricultural Farm Buildings, the Live Stock Judging and Dairy Buildings, the Horticultural Building and greenhouses, and Read Hall, the Dormitory for women. The Gymnasium for women is located in Academic Hall.

THE SCHOOL OF ENGINEERING.

It is the aim of the School of Engineering to provide a substantial foundation for the general and technical knowledge needed by the successful Engineer by giving students thorough training in the fundamental principles which underlie all Engineering practice, and in the principles of the various special branches of Engineering together with such applications in the several fields of practice as are feasible in a technical school. To this end four undergraduate curricula are offered, leading to the degrees of Bachelor of Science in Civil Engineering, Electrical Engineering, Mechanical Engineering, Sanitary Engineering and Chemical Engineering. These degrees will not be granted after the session of 1914-15, and students will not be admitted to the curricula leading to these degrees after June, 1911. Special attention is called to the new three-year professional curricula which were offered for the first time in 1909-10. These curricula require two years of college work (the equivalent of 60 hours credit in the College of Arts and Science) for entrance; consist of three years (90 hours credit) of technical engineering work and lead to the degrees of Civil Engineer, Electrical Engineer, Mechanical Engineer, and Chemical Engineer.

The curricula in **Civil Engineering** embrace topographical, railway, hydraulic, structural, municipal, sanitary and highway Engineering, and the purpose is to give a broad, general training which may later serve as a foundation for the development of any of the special lines of practice included under the general term, Civil Engineering.

The curricula in **Electrical Engineering** are intended to furnish general training for the practice of Electrical Engineering as **a profession**, that is a thorough, broad, training for Electrical Ennigeers. The technical work consists of the theory and principles of electricity and magnetism; electrical measurements; calibration of instruments; tests of all kinds; design and construction; study of problems in the generation, transmission, distribution, and utilization of electrical energy. Special attention is paid to alternating current phenomena.

The curricula in **Mechanical Engineering** are intended to fit students to enter readily any of the principal divisions of Mechanical Engineering. Training is given in the underlying principles of the profession, all work being so arranged that the application of those principles to special problems, which may arise in practice, may clearly be seen. The design of Engineering structures and machines, and the development, application, and measurement of power in its various forms are covered in the different courses.

The curricula in **Chemical Engineering** are offered to furnish training in Engineering together with specialization in Chemistry.

REQUIREMENTS FOR ADMISSION.

Fifteen (15) units are required for admission to the undergraduate curricula in the School of Engineering, and 60 hours Arts and Science credit for entrance to the three-year professional curricula.

A unit represents the equivalent of a year's work of nine months in one subject, in a good high school, normal school, or college, with five periods a week in the class-room or laboratory, each period of about forty minutes.

Three of these units must be in English, one and one-half in Algebra, one in Plane Geometry, one-half in Solid Geometry, two in foreign languages, and one in science. The additional units required may be selected from the following list:

English—one unit.

Plane Trigonometry or **Civil Government**—one-half unit.

Physics, Chemistry, Biology, Zoology, or **Botany**—one to two units.

Drawing, Manual Training, Physiography or **Agriculture**—one unit.

History or **Latin**—one to four units.

German, French, Spanish, or **Greek**—one to three units. It is strongly recommended that students present two units in French or German to meet the requirements in foreign language.

The courses in Engineering require that the students be strong in Mathematics and Science. Those who are not strong in these subjects are advised not to undertake work in Engineering.

ENTRANCE EXAMINATIONS AND CERTIFICATES.

Time of Entrance Examinations:

Examinations for admission will be held at the University, September 19, 20 and 21, 1910. All persons desiring to enter the University during the first semester of the session of 1910-11 except those holding certificates of graduation from Accredited Schools and those who have already otherwise fulfilled the entrance requirements must take these examinations. They should present themselves at the Registrar's office, room 18, Academic Hall, at 8 a. m., Monday. September 19, to receive directions concerning the examinations.

Students who enter late are required to pay additional fees and are examined or conditioned on the work already done by their classes.

The University will admit without examination such graduates of an Accredited School as bring proper credentials of the fact that they have completed the subjects required for entrance.

The diploma will not be accepted as a credential. The student must present the proper form of certificate signed by the Principal or Superintendent of the Accredited School. Blank certificates will be furnished by the Dean upon application. These certificates should be filled out and sent to the Committee on Entrance, Columbia, Missouri.

Students who do not hold certificates of graduation from an Accredited School may present their grades in any subject. In such cases they should have the grades certified by the proper official of the school in which the grades were made.

As the necessity for correction appears in many instances, the student may avoid delay and inconvenience by sending certificates in advance of the opening of the session.

SPECIAL STUDENTS.

Persons who desire to follow special lines of work, and who have not had the preliminary preparation required for admission as regular students, may be admitted by the Dean as Special Students for the purpose of pursuing courses for which their preparation fits them. Such students *must* be at least 21 years old and must satisfy the Dean, that they can, with profit to themselves, pursue the work selected, and they are required to maintain the same standard of excellence which is required of regular students. No Special Student may be a candidate for a degree unless he completes the requirements for entrance, and enters in regular standing before the beginning of the senior year.

ADVANCED STANDING.

Applicants for advanced standing are required to present credentials showing honorable dismissal and completion of courses equivalent to those for which they seek credit. Claims for advanced standing must be made by the student within one semester after entrance. Those who wish it may have their claims passed upon by the Dean before matriculation.

FEES AND EXPENSES.

Tuition is $10 a semester in the School of Engineering. Students in the School of Engineering pay an annual Library and Incidental fee of $10. A Laboratory deposit is required for each laboratory course. This deposit covers a fixed laboratory charge and charges for material used and damage to apparatus.

The cost of board and room rent in the University Dormitories varies from $2.50 to $3.50 per week. Board and lodging elsewhere costs from $3.50 to $5.00 a week. A careful estimate of the necessary expenses of the Freshman year for men living in University Dormitories is given in the table below:

ESTIMATE OF NECESSARY EXPENSES OF FRESHMAN YEAR FOR MEN LIVING IN UNIVERSITY DORMITORIES.

Library and Incidental Fee	$ 10 00
Tuition	20 00
Laboratory Deposits:	
Shop	10 00
Chemistry	10 00
Drawing	2 00
Surveying	5 00
Room Rent	27 00
Extra Furnishing of Room	5 00
Dining Room Permit	22 00
Dining Room Initiation Fee	1 00
Caution Deposit	8 00
Board, 40 Weeks	60 00
Books, Stationery, Etc.	25 00
Drawing Instruments and Material	20 00
Laundry	10 00
Incidentals	25 00
	$260 00

Fees and deposits are payable in advance, and books, instruments, etc., have to be purchased at the beginning of the year.

A fee of $5.00 is imposed for late entrance.

LIBRARY.

The School of Engineering is equipped with an excellent working library of technical books, and with the best Engineering magazines. This Department library is in the Engineering Building and is open during the day and in the evening.

The General Library of the University contains many books and pamphlets, and is open to all students of the University. Books may, under regulations, be drawn from the Library.

The Library and Reading Room of the Missouri State Historical Society, located in Academic Hall, are open to all students of the University.

SOCIETIES.

There is a flourishing Engineering Society, composed of members of the Junior and Senior classes, which affords opportunity for discussion of current Engineering topics, and brings the students and faculty together in a social way. The Engineering Society publishes The Engineering Quarterly, a periodical devoted to Engineering interests.

There are chapters of the Honorary Societies of Sigma Xi and Tau Beta Pi, to which honor students are elected. A Branch of the American Institute of Electrical Engineers offers exceptional opportunities to students in Electrical Engineering, and a Branch of the American Society of Mechanical Engineers gives similar advantages for students in Mechanical Engineering.

ATHLETICS.

There is an excellent gymnasium, golf links, tracks, tennis courts, and athletic fields. Work in physical training and athletics is thoroughly organized. The students have teams for football, basketball, track athletics and tennis.

Freshmen are required to take a course of one hour's credit in Military or in Physical Training.

NONRESIDENT LECTURERS.

During the session lectures are delivered on Engineering subjects by prominent Engineers. These lectures are especially valuble as they bring the students in touch with the commercial and practical side of actual engineering work.

LABORATORIES.

The School of Engineering maintains Laboratories equipped for the principal experimental work required of Engineers. The apparatus is modern and great care has been taken in its selection.

CIVIL ENGINEERING.

†F. P. Spalding, Professor; W. S. Williams, A. Lincoln Hyde, Wm. A. Miller, Assistant Professors; †Earl Querbach, F. W. Capp, Instructors; W. Roberts and F. A. Muth, Assistants.

This department is equipped with instruments for testing and surveying. There are transits, levels, plane tables, compasses, sextants, tapes, and small instruments for land, topographical and railway surveys; and an 8-inch Fauth theodolite, Brandis triangulation transit, Saegmuller precise level, base apparatus, etc., for geodetic surveys.

In the laboratory for testing materials there are: a standard abrasion cylinder for paving brick, three testing machines arranged for tension, compression and transverse tests, and Olsen torsion machine, extensometers, gauges, compression micrometers, and small tools and instruments needed for tests of iron, steel, wood, brick, etc. The cement laboratory is fitted for all standard tests. There are Olsen and Fairbanks testing machines, mortar mixer, briquette press, apparatus for heat tests, Vicat and Gilmore needles for rate of setting, appliances for fineness and specific gravity tests, glass mixing tables, and a good outfit of moulds and other small instruments.

For office work there are rolling and polar planimeters, a pantagraph, topographical protractors, stadia charts, and slide rule, Thatcher calculating instrument, beam compass, etc. About 500 drawings of recent bridges, presented by Mr. T. G. Wilkerson (class of 1890) of Pittsburg, and a set of 130 drawings, carefully arranged and indexed, presented by Dr. J. A. L. Waddell, illustrating recent practice in bridge design, are available for instruction.

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†On leave of absence first semester of 1910-11.

FOUR YEAR CURRICULUM LEADING TO THE DEGREE OF BACHELOR OF SCIENCE IN CIVIL ENGINEERING.

(Fifteen units of high school work required for entrance.)

General Subject.	No. of Course.	Special Title.	1st Sem.	2d Sem.
FRESHMAN YEAR.				
Mathematics	3a	Trigonometry and Algebra	5	0
Mathematics	4b	Analytical Geometry	0	5
English	1b	Composition and Rhetoric	0	5
Chemistry	2a	General Inorganic Chemistry	5	0
Drawing	1a	Mechanical Drawing	5	0
Drawing	4b	Topographic Drawing	0	1
Shopwork	1b	Woodwork and Forging	0	1
Civil Engineering	2b	Elementary Surveying	0	2
	1b	Introduction to Engineering	0	1
SOPHOMORE YEAR.				
Mathematics	5a	Differential Calculus	4	0
Mathematics	6b	Integral Calculus	0	4
Physics	3	General Physics	5	5
Economics	2a	Principles of Economics	2	0
Drawing	2b	Descriptive Geometry	0	2
Civil Engineering	4a	Higher Surveying	3	0
Civil Engineering	11b	Railway Surveying	0	4
Civil Engineering	51a	Roads and Sewers	2	0
JUNIOR YEAR.				
Mechanics	3	Mechanics of Engineering	4	4
Astronomy	3	Spher. and Prac. Astronomy	2	2
Mechanical Engineering	31a	Engines and Boilers	2	0
Civil Engineering	12a	Railway Engineering	4	0
Civil Engineering	21	Framed Structures	3	3
Civil Engineering	25b	Masonry Structures	0	4
Civil Engineering	32b	Materials of Construction	0	2
SENIOR YEAR.				
Mechanical Engineering	24b	M. E. Laboratory	0	1
Civil Engineering	5b	Geodetic Surveying	0	3
Civil Engineering	22a	Bridge Design	5	0
Civil Engineering	26a	Concrete Structures	2	0
Civil Engineering	33a	Testing Laboratory	1	0
Civil Engineering	41a	Hydraulic Machinery	2	0
Civil Engineering	42b	Hydraulic Design	0	2
Civil Engineering	52a	Sanitary Engineering	2	0
Civil Engineering	61b	Specifications and Contracts	0	1
Civil Engineering	100b	Thesis	0	2
Elective	......	....	3	5

THREE YEAR CURRICULUM LEADING TO THE DEGREE OF CIVIL ENGINEER.

For entrance to this curriculum, two years of college work, (equivalent to 60 hours credit in the College of Arts and Science) are required.

The degree of Civil Engineer is awarded upon the completion of 90 credit hours, including the following courses:

THREE YEAR CURRICULUM LEADING TO THE DEGREE OF CIVIL ENGINEER.

General Subject.	No. of Course.	Special Title.	Hours Credit.
Drawing	1a or 1b	Mechanical Drawing	5
Drawing	2a or 2b	Descriptive Geometry	2
Drawing	4a	Topographical Drawing	1
Mechanics	3	Mechanics of Engineering	8
Geology	6a or 6b	Geology for Engineers	3
Astronomy	3	Spher. and Prac. Astronomy	4
Mechanical Engineering	31a	Engines and Boilers	2
Mechanical Engineering	24b	M. E. Laboratory	1
Civil Engineering	1a or 2b	Elementary Surveying	2
Civil Engineering	4a	Higher Surveying	3
Civil Engineering	5b	Geodetic Surveying	3
Civil Engineering	11b	Railway Surveying	4
Civil Engineering	12b	Railway Engineering	4
Civil Engineering	21	Framed Structure	6
Civil Engineering	22a	Bridge Design	5
Civil Engineering	23b	Higher Structures	3
Civil Engineering	25b	Masonry Structures	4
Civil Engineering	26a	Concrete Structures	2
Civil Engineering	32b	Materials of Construction	2
Civil Engineering	33a	Testing Laboratory	1
Civil Engineering	41a	Hydraulic Machinery	2
Civil Engineering	42b	Hydraulic Design	2
Civil Engineering	51a	Roads and Sewers	2
Civil Engineering	52a	Sanitary Engineering	2
Civil Engineering	61b	Specific. and Contracts	1
Civil Engineering	100b	Thesis	2
Elective			14

ELECTRICAL ENGINEERING.

H. B. SHAW, Professor; A. E. FLOWERS, Assistant Professor; M. P. WEINBACH, E. W. KELLOGG, Instructors.

To furnish thorough training for Electrical Engineers, the individual studies have been very carefully selected and arranged, the technical subjects being varied somewhat from year to year to meet the demands of a rapidly developing profession.

Instruction is given by means of recitations, lectures, and laboratory work, thoroughly correlated, the idea being to present each subject to the student as a whole, and from all points of view. A feature of considerable interest is a Branch of the American Institute of Electrical Engineers. The department of Physics has charge of the special course in Electrical Measurement.

Attention is called to the studies, Steam Engineering, Kinematics, Hydraulic Motors, and Mechanical Laboratory under the direct charge of the department of Mechanical Engineering.

For the laboratory work in Electrical Engineering distinctively there are the following laboratories: Dynamo Laboratory for Direct and Alternating Currents. Standardizing Laboratory for the calibration of instruments, Laboratory for the testing of Materials used in Electrical Construction. These Laboratories are equipped with different types, makes, and sizes of motors, and generators, together with ammeters, volt-meters, and other instruments and accessories. Facilities for research work are continually being improved, each graduate being required to present a thesis evidencing original work.

FOUR YEAR CURRICULUM LEADING TO THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING.

(Fifteen units of High School work required for entrance.)

General Subject.	No. of Course.	Special Title.	1st Sem.	2nd Sem.
Freshman Year.				
Mathematics	3a	Algebra and Trigonomety	5	0
Mathematics	4b	Analytic Geometry	0	5
English	1a	Composition and Rhetoric	5	0
Drawing	1b	Mechanical Drawing	0	5
Chemistry	2a or 2b	General Inorganic Chemistry	0–5	5–0
Shopwork	1a or 1b	Woodwork and Forging	2–0	0–2
Shopwork	2a or 2b	Pattern Making	2–0	0–2
		Introduction to Engineering	1–0	0–1
Sophomore Year.				
Mathematics	5a	Differential Calculus	4	0
Mathematics	6b	Integral Calculus	0	4
Economics	2a	Principles of Economics	0	4
Physics	3	General Physics	5	5
Shopwork	3	Machine Work	2	2
Drawing	2a	Descriptive Geometry	2	0
Civil Engineering	1a	Elementary Surveying	2	0
Junior Year.				
Mechanics	3	Mechanics of Engineering	4	4
Electrical Engineering	1	Electrical Machinery	4	4
Physics	4	Electrical Measurements	5	0
Electrical Engineering	2	Elementary Alternating Currents	0	5
Electrical Engineering	6	Seminary	1	1
Senior Year.				
Mechanical Engineering	33	Prime Movers	3	3
Mechanical Engineering	23	Mechanical Laboratory	1	1
Electrical Engineering	3	Adv. Alternating Currents	5	0
Electrical Engineering	4	Electrical Design	3	3
Electrical Engineering	5	Electrical Engineering	3	3
Electrical Engineering	7b	Thesis	0	2
		Elective	0	3

THREE YEAR CURRICULUM LEADING TO THE DEGREE OF ELECTRICAL ENGINEER.

For entrance to this Curriculum, two years of college work, the equivalent of 60 hours' credit in the College of Arts and Science, are required.

The degree of Electrical Engineer is awarded upon the the completion of 90 hours' credit, including the following courses:

General Subject.	No. of Course.	Special Title.	Hours Credit.
Drawing	1	Mechanical Drawing.	5
Drawing	2	Descriptive Geometry	2
Shopwork	1	Woodwork and Forging	2
Shopwork	2	Pattern Making	2
Shopwork	3	Machine Work	4
Civil Engineering	1	Elementary Surveying	2
Mechanics	3	Mechanics of Engineering	8
Physics	4	Electrical Measurements	5
Mechanical Engineering	33	Prime Movers	6
Mechanical Engineering	23	Mechanical Laboratory	2
Electrical Engineering	1	Electrical Machinery	8
Electrical Engineering	2	Elementary Alternating Currents	5
Electrical Engineering	3	Advanced Alternating Currents	5
Electrical Engineering	4	Electrical Design	6
Electrical Engineering	5	Electrical Engineering	6
Electrical Engineering	6	Seminary	2
Electrical Engineering	7b	Thesis	2
Elective	..	..	18

MECHANICAL ENGINEERING.

H. W. Hibbard, Professor; E. A. Fessenden, A. L. Westcott, H. S. Philbrick, Assistant Professors; J. R. Wharton, Instructor.

The study of the Science of Machinery is intended to fit young men to secure the greatest advantage from the practical experience which must precede, accompany or follow this study, and to enable them to be of earlier and greater responsible value in connection with Engineering Properties, as designers, in testing and inspection work, in engineering salesmanship or other associated specialties, in power plant operation, in manufacturing and industrial management, and in improvement of existing or in creation of new properties.

The laboratory is equipped with steam, gas, and oil engines, steam turbine, water wheels, injectors, pumps, air compressors, fans, blowers, hoisting appliances, and apparatus for standardizing instruments. A large number of indicators, planimeters, thermometers, and water meters are used on tests, and the properties of oils, coals, transmission material, and gases are determined by apparatus for these purposes.

The work in the laboratory is to familiarize the student with the use and care of these machines as well as with the principles underlying the design, construction, and application. In equipping the laboratory it has been the aim to select apparatus which would bring the student in contact with most of the important forms or types of machines for developing and measuring power. It is also the intention to have him make most of the tests which a Mechanical Engineer is called upon to execute, and at the same time an attempt is made to have the student make original investigations on simple problems.

FOUR YEAR CURRICULUM LEADING TO THE DEGREE OF BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING.

(Fifteen units of High School work required for entrance.)

General Subject.	No. of Course.	Special Title.	1st Sem.	2d Sem.
FRESHMAN YEAR.				
Mathematics.	3a	Algebra and Trigonometry	5	0
Mathematics	4b	Analytical Geometry	0	5
English	1a	Composition and Rhetoric	5	0
Chemistry	2	General Inorganic Chemistry	0 or 5	5 or 0
Drawing	1b	Mechanical Drawing	0	5
Shopwork	1a	Woodwork and Forging	2 or 0	0 or 2
Shopwork	2b	Pattern Making	2 or 0	0 or 2
Engineering	1a or 1b	Introduction to Engineering	1 or 0	0 or 1
			15	15
SOPHOMORE YEAR.				
Mathematics	5a	Differential Calculus	4	0
Mathematics	6b	Integral Calculus	0	4
Physics	3	General Physics	5	5
Drawing	2a	Descriptive Geometry	2	0
Economics	2b	Principles of Economics	0	2
Shopwork	3	Machine Work	2	2
Civil Engineering	1a	Elementary Surveying	2	0
Mechanical Engineering	1b	Elementary Mechanisms	0	2
			15	15
JUNIOR YEAR.				
Mechanics	3	Mechanics of Engineering	4	4
Electrical Engineering	1	Electrical Machinery	4	3
Mechanical Engineering	2a	Engineering Materials	2	0
Mechanical Engineering	3b	Elementary Machine Design	0	3
Mechanical Engineering	32	Steam Machinery	3	3
Mechanical Engineering	21	Elementary Mechanical Lab	2	2
			15	15
SENIOR YEAR.				
Mechanical Engineering	35a	Heat Engines	3	0
Mechanical Engineering	36a	Steam Turbines	2	0
Mechanical Engineering	37b	Gas Engines	0	2
Mechanical Engineering	39	Steam Engineering	3	5
Mechanical Engineering	4a	Abvanced Machine Design	3	0
Civil Engineering	24b	Mill Structures	0	2
Mechanical Engineering	22	Advanced Mechanical Lab	2	2
Civil Engineering	61b	Specifications and Contracts	0	1
Mechanical Engineering	12b	Handling of Men	0	1
		Elective	2	0
Mechanical Engineering	62b	Thesis	0	2
			15	15

THREE YEAR CURRICULUM LEADING TO THE DEGREE OF MECHANICAL ENGINEER.

For entrance to this curriculum, two years of college work, equivalent to 60 hours' credit in the College of Arts and Science, are required.

The degree of Mechanical Engineer is awarded upon the completion of 90 credit hours, including the following courses:

General Subject.	No. of Course.	Special Title.	Hours Credit.
Drawing	1a or 1b	Mechanical Drawing	5
Drawing	2a or 2b	Descriptive Geometry	2
Shopwork	1a	Woodwork and Forging	2
Shopwork	2b	Pattern Making	2
Shopwork	3	Machine Work	4
Civil Engineering	1a	Elementary Surveying	2
Mechanics	3	Mechanics of Engineering	8
Electrical Engineering	1	Electrical Machinery	7
Civil Engineering	24b	Mill Structures	2
Civil Engineering	61b	Specifications and Contracts	1
Mechanical Engineering	1b	Elementary Mechanisms	2
Mechanical Engineering	2a	Engineering Materials	2
Mechanical Engineering	3b	Elementary Machine Design	3
Mechanical Engineering	4a	Advanced Machine Design	3
Mechanical Engineering	21	Elementary Mechanical Lab.	4
Mechanical Engineering	22	Advanced Mechanical Lab.	4
Mechanical Engineering	32	Steam Machinery	6
Mechanical Engineering	35a	Heat Engines	3
Mechanical Engineering	36a	Steam Turbines	2
Mechanical Engineering	37b	Gas Engines	2
Mechanical Engineering	39	Steam Engineering	8
Mechanical Engineering	12b	Handling of Men	1
Mechanical Engineering	62b	Thesis	2
Elective,	....	....	13
			90

CHEMICAL ENGINEERING.

In view of the development of the application of Chemistry on a large scale in manufacturing, curricula are offered to furnish training in Engineering, together with specialization in Chemistry.

FOUR YEAR CURRICULUM LEADING TO THE DEGREE OF BACHELOR OF SCIENCE IN CHEMICAL ENGINEERING.

(Fifteen units of High School credits required for entrance.)

General Subject.	No. of Course.	Special Title	1st Sem.	2nd Sem.
Freshman Year.				
Mathematics	3a	Algebra and Trigonometry	5	0
Mathematics	4b	Analytical Geometry	0	5
English	1b	Composition and Rhetoric	0	5
Drawing	1a	Mechanical Drawing	5	0
Chemistry	2a	General Inorganic Chemistry	5	0
Chemistry	7b	Qualitative Analysis	0	5
Engineering	1a or 1b	Introd. to Engineering	1 or 0	0 or 1
Sophomore Year.				
Mathematics	5a	Differential Calculus	4	0
Mathematics	6b	Integral Calculus	0	4
Physics	3	General Physics	5	5
Chemistry	11	Organic Chemistry	3	3
Drawing	2b	Descriptive Geometry	0	2
Mechanical Engineering	1b	Elementary Mechanisms	0	2
Chemistry	21	Quantitative Analysis	3	0
Junior Year.				
Mechanics	3	Mechanics of Engineering	4	4
Chemistry	18	Physical Chemistry	3	3
Electrical Engineering	1	Electrical Machinery	4	4
Mechanical Engineering	33	Prime Movers	3	3
Mechanical Engineering	23	Mechanical Laboratory	1	1
Senior Year				
Chemistry	10	Technical Chemistry	3	3
Physics	4	Electrical Measurements	5	0
Mechanical Engineering	3b	Machine Design	0	3
Economics	2a	Principles of Economics	2	0
Chemistry	....	Thesis	0	2
		Elective	4	6

THREE YEAR CURRICULUM LEADING TO THE DEGREE OF CHEMICAL ENGINEER.

For entrance to this curriculum two years of college work, the equivalent of 60 hours' credit in the College of Arts and Science are required.

The completion of 90 hours' credit is required, including the following courses:

General Subject.	No. of Course.	Special Title.	Hours Credit.
Drawing	1	Mechanical Drawing	5
Drawing	2	Descriptive Geometry	2
Mechanical Engineering	1	Elementary Mechanisms	2
Mechanics	3	Mechanics of Engineering	8
Electrical Engineering	1	Electrical Machinery	8
Mechanical Engineering	33	Prime Movers	6
Mechanical Engineering	23	Mechanical Laboratory	2
Physics	4	Electrical Measurements	5
Mechanical Engineering	....	Elementary Machinery Design	3
Chemistry	7	Qualitative Analysis	5
Chemistry	11	Organic Chemistry	6
Chemistry	21	Quantitative Analysis	3
Chemistry	18	Physical Chemistry	6
Chemistry	10	Technical Chemistry	6
Chemistry	14a or 14b	Industrial Chemistry	3
		Thesis	2
Elective	....	....	18
			90

GRADUATE WORK.

Students who have been granted bachelor's degrees in Engineering by this University or by one of equivalent standing, will be admitted as graduate students in Engineering and to candidacy for the degrees of Civil Engineer (C. E.), Electrical Engineer (E. E.), Mechanical Engineer (M. E.), and Chemical Engineer (Ch. E.). The normal requirements for these degrees are credits for one full year of graduate work in residence and an acceptable thesis.

No new students will hereafter be admitted to graduate work in absentia.

All graduate students must be regularly admitted, paying the usual fees.

The thesis subject shall be presented to the Dean of the School of Engineering on or before December 1, and the thesis itself on or before May 1 of the given year. The graduate work is under the direct charge of the heads of the respective departments.

For a general catalogue of the University, address the University Publisher, Columbia, Missouri. For further information concerning the School of Engineering, address H. B. Shaw, Dean, Columbia, Missouri.

UNIVERSITY CALENDAR.

FIRST SEMESTER.

September 19, 20, 21 Entrance Examinations and Registration
September 22, Thursday, at 8 a. m. ....
Class Work in All Departments Begins
September 22, Thursday, at 10 a. m...Opening Convocation
November 23, Wednesday, at 12 m. to
November 28, Monday, at 8 a. m...Thanksgiving Holidays
December 13..............Semi-Annual Meeting of Curators
December 22, Thursday, at 4 p. m. to } Christmas Holidays
1911—January 3, Tuesday, at 8 a. m. .... }
January 28, Saturday, to
February 4, Saturday............Mid-Year Examinations

SECOND SEMESTER

February 1, 2, 3, Wednesday, Thursday and Friday
Entrance Examinations
February 6, Monday, at 8 a. m. ....
Class Work in All Departments Begins
February 9, Thursday, at 10 a. m......Opening Convocation
February 22, Wednesday, Washington's Birthday....Holiday
April 6, Thursday...........Quarterly Meeting of Curators
May 27, Saturday, to June 3, Saturday....Final Examinations
June 3, Saturday....................Stephens Medal Contest
June 4, Sunday......................Baccalaureate Sermon
June 5, Monday.................................Class Day
June 5, 6, 7, Monday, Tuesday and Wednesday.......
Entrance Examinations
June 6, Tuesday......................Phi Beta Kappa Day
June 7, Wednesday.............................Alumni Day
June 8, Thursday...............Annual Meeting of Curators
June 8, Thursday.......................Commencement Day

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1911/12

THE
UNIVERSITY OF MISSOURI
BULLETIN

GENERAL SERIES
VOLUME [illegible]

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ANNOUNCEMENT
OF THE
SCHOOL OF ENGINEERING
1911-12

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UNIVERSITY OF MISSOURI
COLUMBIA, MISSOURI
September, 1911

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2000

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UNIVERSITY CALENDAR AT COLUMBIA.

SUMMER SESSION.

1911—June 9, Friday .... Registration, Summer Session
June 10, Saturday.................. Organization of Classes
August 9, Wednesday..................... Lectures Close
August 10, Thursday }
August 11, Friday } .... Examinations

First Semester.

September 18, 19, 20.. Entrance Examinations and Registration
September 21, Thursday, at 8 a. m.
Class Work in all Divisions Begins
September 21, Thursday, at 10 a. m.... Opening Convocation
November 30, Thursday, Thanksgiving Day.......... Holiday
December 12, Tuesday..... Semi-Annual Meeting of Curators
December 22, Friday, at 12 m. to.. }
1912—January 3, Wednesday, at 9 a. m. } ...... Christmas Holidays
January 27, Saturday, to
February 3, Saturday........... Mid-Year Examinations

Second Semester.

January 31, February 1, 2, Wednesday, Thursday
and Friday .... Entrance Examinations
February 2, 3, 5, 6, Friday, Saturday, Monday and
Tuesday............. Registration, Second Semester
February 7, Wednesday, at 8 a. m.
Class Work in All Divisions Begins
February 8, Thursday, at 10 a. m.... Opening Convocation
February 22, Thursday, Washington's Birthday...... Holiday
April 4, Thursday........... Quarterly Meeting of Curators
April 4, Thursday at 4 p. m. to April 9,
Tuesday at 9 a. m.................... Easter Holidays
June 1, Saturday to June 8, Saturday.... Final Examinations
June 8, Saturday.................. Stephens Medal Contest
June 9, Sunday.................. Baccalaureate Sermon
June 10, Monday............................ Class Day
June 10, 11, 12, Monday, Tuesday and Wednesday
Entrance Examinations
June 11, Tuesday..................... Class Re-union Day
June 12, Wednesday......................... Alumni Day
June 13, Thursday............. Annual Meeting of Curators
June 13, Thursday.................. Commencement Day

THE UNIVERSITY OF MISSOURI.

The University of Missouri was located at Columbia, Missouri, in 1839, and instruction in Academic work was begun in 1841. In the course of its development the institution has found itself called upon to organize several departments of instruction and administration in response to the needs of the several vocations followed by the citizens of the State.

The present organization, with two colleges (Arts and Science, and Agriculture) and schools for professional and graduate work, was adopted May 31, 1909. The separate divisions, each of which was in some form differentiated from the rest of the institution in the year indicated, are as follows:

I. College of Arts and Science (1839).
II. School of Education (1867).
III. College of Agriculture (1870).
IV. School of Mines and Metallurgy at Rolla (1870).
V. School of Law (1872).
VI. School of Medicine (1873).
VII. School of Engineering (1877).
VIII. Graduate School (1896).
IX. School of Journalism (1906).

In addition, special emphasis is given particular lines of work by the establishment and operation of special minor divisions, the chief of which are the Extension Division, the Agricultural Experiment Station, the Engineering Experiment Station, and the Military Department. All of these divisions are located at Columbia with the exception of the School of Mines and Metallurgy, which is situated at Rolla.

Columbia, a town of about 10,000 inhabitants, is situated near the center of the State, half way between St. Louis and Kansas City. It is reached from the east, north, and west by the Wabash Railroad, and connecting lines. The Missouri, Kansas and Texas Railroad affords a direct route to Columbia to persons living on that line, and to those living on the Missouri Pacific, St. Louis and San Francisco, and other southern railroads.

The surrounding region is elevated, well drained and diversified. The University grounds comprise over seven hundred acres of undulating land in the southern part of the town and its outskirts. The main divisions of the grounds are the Quadrangle of thirty-two acres.

the Horticultural grounds of thirty acres, the Physical Education grounds, and the Experiment Farm of 648 acres.

The University has the following buildings at Columbia: Academic Hall, Laws Observatory, separate buildings for Chemistry, Zoology and Geology; Engineering, and Mechanic Arts; three power-houses; Medical Laboratory Building, Parker Memorial Hospital including the Busch Clinic, and an Animal Building; Agricultural Building, Horticultural Building and Green Houses, Live-Stock Judging, Dairy, Farm Machinery, and Veterinary Buildings, and the Agricultural Farm Barns and Buildings; Switzler Hall (Journalism); the President's House, and the dwelling of the Dean of the College of Agriculture; Benton and Lathrop Halls (dormitories for men), Read Hall (dormitory for women), and the Gymnasium (for men). The women's Gymnasium is housed in Academic Hall, and the practice schools of the School of Education in an old dwelling belonging to the University and in a good building, originally erected for an academy.

FACULTY OF THE SCHOOL OF ENGINEERING.

ALBERT ROSS HILL, A. B., Ph. D., LL. D.,
President of the University.

HOWARD BURTON SHAW, A. B., B. C. E., A. M.,
Professor of Electrical Engineering, and Dean of the Faculty.

EDWIN BAYER BRANSON, A. B., A. M., Ph. D.,
Professor of Geology.

CHESTER LELAND BREWER,
Professor of Physical Education and Director of Gymnasiums and Athletics.

WILLIAM GEORGE BROWN, B. S., Ph. D.,
Professor of Industrial Chemistry.

SIDNEY CALVERT, B. S., A. M.,
Professor of Organic Chemistry.

HERBERT JOSEPH DAVENPORT, Ph. B., Ph. D.,
Professor of Economics.

LUTHER MARION DEFOE, A. B.,
Professor of Mechanics.

EARL RAYMOND HEDRICK, A. B., A. M., Ph. D.,
Professor of Mathematics.

HERBERT WADE HIBBARD, A. B., A. M., M. E.,
Professor of Mechanical Engineering.

OLIVER DIMON KELLOGG, A. B. A. M., Ph. D.,
Professor of Mathematics.

*CURTIS FLETCHER MARBUT, B. S., A. M.,
Professor of Geology and Mineralogy.

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*On leave of absence, session of 1911-12.

HERMAN SCHLUNDT, B. S., M. S., Ph. D.,
Professor of Physical Chemistry.

FREDERICK PUTNAM SPALDING, C. E.,
Professor of Civil Engineering.

OSCAR MILTON STEWART, Ph. B., Ph. D.,
Professor of Physics.

____
Professor of Astromony.

LEWIS DARWIN AMES, A. B., A. M., Ph. D.,
Assistant Professor of Mathematics.

SPURGEON BELL, B. S.,
Assistant Professor of Economics.

EDWIN ALLEN FESSENDEN, B. S. in M. E., M. E.,
Assistant Professor of Mechanical Engineering.

*ALAN ESTIS FLOWERS, M. E.,
Assistant Professor of Electrical Engineering.

ABRAHAM LINCOLN HYDE, Ph. B.,
Assistant Professor of Bridge Engineering.

CHARLES PHILLIPS HUSE, Ph. D.,
Assistant Professor of Economics.

WILLIAM ALVIN MILLER, B. S. in C. E.,
Assistant Professor of Railway Engineering.

RAYMOND DURBIN MILLER, A. B., Ph. D.,
Assistant Professor of English.

HERBERT SHAW PHILBRICK, A. B., S. B.,
Assistant Professor of Mechanical Engineering.

HERBERT MEREDITH REESE, A. B., Ph. D.,
Assistant Professor of Physics.

HARVEY CLAYTON RENTSCHLER, A. B., A. M., Ph. D.,
Assistant Professor of Physics.

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*On leave of absence, session of 1911-12.

THOMAS JACOB RODHOUSE, B. S. in C. E., M. C. E.,
Assistant Professor of Hydraulic Engineering.

ROBERT WASHINGTON SELVIDGE, B. S., A. M.,
Assistant Professor of Manual Arts.

ARTHUR LORD WESTCOTT, B. M. E., M. E.,
Assistant Professor of Mechanical Engineering.

WILHELMUS DAVID ALLEN WESTFALL, A. B., Ph. D.,
Assistant Professor of Mathematics.

WALTER SCOTT WILLIAMS, C. E.,
Assistant Professor of Topographic Engineering.

FRANK WILLIAM CAPP, B. S. in C. E.,
Instructor in Civil Engineering.

WILLIAM CLARENCE DAVIDSON, B. S. in C. E., C. E.,
Instructor in Mechanical Drawing.

OTTO DUNKEL, M. E., B. A., A. M., Ph. D.,
Instructor of Mathematics.

JAMES ANDREW GIBSON, B. A., M. A.,
Instructor in Analytical Chemistry.

LOUIS INGOLD, A. B., A. M., Ph. D.,
Instructor in Mathematics.

EDWARD WASHBURN KELLOGG, C. E.,
Instructor in Electrical Engineering.

CECIL S. LYNCH, B. S. in E. E.,
Instructor in Manual Arts.

ERNEST EARL MORLAN, A. B., A. M.,
Instructor in Chemistry.

*EARL QUERBACH, B. S. in C. E., C. E.,
Instructor in Bridge Engineering.

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*On leave of absence, session of 1911-12.

RALPH E. ROOT, Ph. D.,
Instructor in Mathematics.

MENDEL PENCO WEINBACH, A. B., B. S. in E. E., A. M.,
Instructor in Electrical Engineering.

AUSTIN HUBBARD WELCH, B. S. in M. E., M. E.,
Instructor in Mechanical Drawing.

JAMES ROY WHARTON, B. S. in M. E., M. E.,
Instructor in Mechanical Engineering.

FRANK ELBERT WHEELOCK, A. B., Ph. D.,
Instructor in Physics.

RAYMOND ADAMS DUTCHER, B. S., M. S.,
Assistant in Chemistry.

IRA JONES, B. S. in Ed.,
Assistant in Physics.

WARREN ROBERTS, B. S. in C. E.,
Assistant in Civil Engineering.

OSCAR C. SCHAEFER, B. S., Ch. E.,
Assistant in Chemistry.

FRANK OTTO SPOHRER, B. S. in Ed.,
Assistant in Chemistry.

STANLEY STOKES,
Assistant in Physics.

CLAYTON WYLIE, A. B.,
Assistant in Astronomy.

THE SCHOOL OF ENGINEERING.

It is the aim of the School of Engineering to provide a substantial foundation for the general and technical knowledge needed by the successful Engineer by giving students thorough training in the fundamental principles which underlie all Engineering practice, and in the principles of the various special branches of Engineering together with such applications in the several fields of practice as are feasible in a technical school. To this end four three-year professional curricula are offered. These curricula require two years of college work (the equivalent of 60 hours credit in the College of Arts and Science) for entrance; consist of three years (90 hours credit) of techincal engineering work and lead to the degrees of Civil Engineer, Electrical Engineer, Mechanical Engineer, and Chemical Engineer.

Four undergraduate curricula are offered leading respectively to the degrees of Bachelor of Science in Civil Engineering, Bachelor of Science in Electrical Engineering, Bachelor of Science in Mechanical Engineering and Bachelor of Science in Chemical Engineering. These curricula will not be offered after the session of 1914-15, and the Freshman year has been discontinued, but students who have already entered these four year curricula may continue the work as outlined for the sophomore, junior and senior years.

The curricula in **Civil Engineering** embrace topograhical, railway, hydraulic, structural, municipal, sanitary and highway Engineering, and the purpose is to give a broad, general training which may later serve as a foundation for the development of any of the special lines of practice included under the general term, Civil Engineering.

The curricula in **Electrical Engineering** are intended to furnish general training for the practice of Electrical Engineering as a profession, that is, a thorough, broad, training for Electrical Engineers. The technical work consists of the theory and principles of electricity and magnetism; electrical measurements; calibration of instruments; tests of all kinds; design and construction; study of problems in the generation, transmission, distribution, and utilization of electrical energy. Special attention is paid to alternating current phenomena.

The curricula in **Mechanical Engineering** are intended to fit students to enter readily any of the principal divisions of Mechanical Engineering. Training is given in the underlying principles of the profession, all work being so arranged that the application of those principles to special problems, which may arise in practice, may clearly be seen. The design of Engineering structures and machines, and the development, application, and measurement of power in its various forms are covered in the different courses.

The curricula in **Chemical Engineering** are offered to furnish training in Engineering together with specialization in Chemistry.

REQUIREMENTS FOR ADMISSION.

Admission to the new three-year professional curricula requires two years of college work, the equivalent of 60 hours credit in the College of Arts and Science. These credits should include: chemistry, 6 hours; calculus, 8 hours; physics, 10 hours. Students who do not present these credits for entrance will be required to take such courses in addition to the other courses in the curricula.

In addition to the above requirements it is desirable that students shall have completed the elementary work in shop work and drawing.

The courses in Engineering require that the students be strong in Mathematics and Science. Those who are not strong in these subjects are advised not to undertake work in Engineering.

SPECIAL STUDENTS.

Persons who desire to follow special lines of work, and who have not had the preliminary preparation required for admission as regular students, may be admitted by the Dean of the University Faculty as Special Students for the purpose of pursuing courses for which their preparation fits them. Such students *must* be at least 21 years old and must demonstrate their fitness to pursue the work selected, with profit to themselves, and they are required to maintain the same standard of excellence with is required of regular students. No Special Student may be a candidate for a degree unless he completes the requirements for entrance, and enters in regular standing before the beginning of the senior year.

ADVANCED STANDING.

Applicants for advanced standing are required to present credentials showing honorable dismissal and completion of courses equivalent to those for which they seek credit. Claims for advanced standing must be made by the student within one semester after entrance. Those who wish it may have their claims passed upon by the Dean before matriculation.

FEES AND EXPENSES.

Tuition is $10 a semester in the School of Engineering. Students in the School of Engineering pay an annual Library and Incidental fee of $10. A Laboratory deposit is required for each laboratory course. This deposit covers a fixed laboratory charge and charges for material used and damage to apparatus.

A careful estimate of the necessary annual expenses of men students for their first two years during which they are matriculated in the College of Arts and Science is given in the table below:

Estimate of Necessary Expenses of Freshman Year for Men Living in Private Homes and Boarding at the University Dining Club.

	Low Estimate	More Liberal Estimate
Library and incidental fee	$10.00	$10.00
Laboratory deposit	10.00	10.00
Room rent (two in room)	36.00	72.00
Dining room permit	25.00	25.00
Dining room initiation fee	1.00	1.00
Caution deposit	5.00	5.00
Board	60.00	60.00
Books and stationery	25.00	40.00
Laundry	10.00	15.00
Incidentals	25.00	50.00
Total	$207.00	$288.00

After matriculation in the School of Engineering, for the last three years of the curricula, the amounts given above must be increased by from $50 to $70 on account of tuition, laboratory fees, drawing instruments and materials, etc.

Fees and deposits are payable in advance, and books, instruments, etc., have to be purchased at the beginning of the year.

A fee of $5.00 is imposed for late entrance.

LIBRARY.

The School of Engineering is equipped with an excellent working library of technical books, and with the best Engineering magazines. This Department library is in the Engineering Building and is open during the day and in the evening.

The General Library of the University contains many books and pamphlets, and is open to all students of the University. Books may, under regulations, be drawn from the Library.

The Library and Reading Room of the Missouri State Historical Society, located in Academic Hall, are open to all students of the University.

SOCIETIES.

There is a flourishing Engineering Society, composed of members of the Junior and Senior classes, which affords opportunity for discussion of current Engineering topics, and brings the students and faculty together in a social way. The Engineering Society publishes The Engineering Quarterly, a periodical devoted to Engineering interests.

There are chapters in the Honorary Societies of Sigma Xi and Tau Beta Pi, to which honor students are elected. A Branch of the American Institute of Electrical Engineers offers exceptional opportunities to students in Electrical Engineering, and a Branch of the American Society of Mechanical Engineers gives similar advantages for students in Mechanical Engineering.

ATHLETICS.

There is an excellent gymnasium, golf links, tracks, tennis courts, and athletic fields. Work in physical training and athletics is thoroughly organized. The students have teams for football, baseball, basketball, track athletics and tennis.

Freshmen are required to take a course of one hour's credit in Military or in Physical Training.

NON-RESIDENT LECTURERS.

During the session lectures are delivered on Engineering subjects by prominent Engineers. These lectures are especially valuable as they bring the students in touch with the commercial and practical side of actual engineering work.

LABORATORIES.

The school of Engineering maintains Laboratories equipped for the principal experimental work required of Engineers. The apparatus is modern and great care has been taken in its selection.

CIVIL ENGINEERING.

F. P. SPALDING, Professor; W. S. WILLIAMS, A. LINCOLN HYDE, WM. A. MILLER, Assistant Professors; *EARL QUERBACH, F. W. CAPP, Instructors; W. ROBERTS, Assistant.

This department is equipped with instruments for testing and surveying. There are transits, levels, plane tables, compasses, sextants, tapes, and small instruments for land, topographical and railway surveys; and an 8-inch Fauth theodolite, Brandis triangulation transit, Saegmuller precise level, base apparatus, etc., for geodetic surveys.

In the laboratory for testing materials there are: A standard abrasion cylinder for paving brick, three testing machines arranged for tension, compression and transverse tests, an Olsen torsion machine, extensometers, gauges, compression micrometers, and small tools and instruments needed for tests of iron, steel, wood, brick, etc. The cement laboratory is fitted for all standard tests There are Olsen and Fairbanks testing machines, mortar mixer, briquette press, apparatus for heat tests, Vicat and Gilmore needles for rate of setting, appliances for fineness and specific gravity tests, glass mixing tables, and a good outfit of moulds and other small instruments.

For office work there are rolling and polar planimeters, a pantagraph, topographical protractors, stadia charts, and slide rule, Thatcher calculating instrument, beam compass, etc. About 500 drawings of recent bridges, presented by Mr. T. G. Wilkerson (class of 1890) of Pittsburg, and a set of 130 drawings, carefully arranged and indexed, presented by Dr. J. A. L. Waddell, illustrating recent practice in bridge design, are available for instruction.

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*On leave of absence, session of 1911-12.

FOUR YEAR CURRICULUM LEADING TO THE DEGREE OF BACHELOR OF SCIENCE IN CIVIL ENGINEERING.

☞ (The freshman year in each of the four year curricula has been discontinued.)

General Subject	No. of Course.	Special Title	1st Sem.	2d Sem.
SOPHOMORE YEAR.				
Mathematics	5a	Differential Calculus	4	0
Mathematics	6b	Integral Calculus	0	4
Physics	3	General Physics	5	5
Economics	2a	Principles of Economics	2	0
Drawing	2b	Descriptive Geometry	0	2
Civil Engineering	104a	Higher Surveying	3	0
Civil Engineering	111b	Railway Surveying	0	4
Civil Engineering	151a	Roads and Pavements	2	0
			16	15
JUNIOR YEAR				
Mechanics	103	Mechanics of Engineering	4	4
Astronomy	3	Spher. and Prac. Astronomy	2	2
Mechanical Engineering	131a	Engines and Boilers	2	0
Civil Engineering	112a	Railway Engineering	4	0
Civil Engineering	121	Framed Structures	3	3
Civil Engineering	125b	Masonry Structures	0	4
Civil Engineering	132b	Materials of Construction	0	2
			15	15
SENIOR YEAR.				
Mechanical Engineering	124b	M. E. Laboratory	0	1
Civil Engineering	105b	Geodetic Surveying	0	3
Civil Engineering	122a	Bridge Design	5	0
Civil Engineering	126a	Concrete Structures	2	0
Civil Engineering	133a	Testing Laboratory	1	0
Civil Engineering	141a	Hydraulic Machinery	2	0
Civil Engineering	145b	Water Supply	0	2
Civil Engineering	152a	Sanitary Engineering	2	0
Civil Engineering	161b	Specifications and Contracts	0	1
Civil Engineering	199b	Thesis	0	2
		Elective	3	5
			15	14

THREE YEAR CURRICULUM LEADING TO THE DEGREE OF CIVIL ENGINEER.

For entrance to this curriculum, two years of college work, (equivalent to 60 hours credit in the College of Arts and Science) are required.

The degree of Civil Engineer is awarded upon the completion of 90 credit hours, including the following courses:

THREE YEAR CURRICULUM LEADING TO THE DEGREE OF CIVIL ENGINEER.

General Subject	No. of Course	Special Title	Hours Credit
Engineering	1a or 1b	Introduction to Engineering	1
Drawing	1a or 1b	Mechanical Drawing	5
Drawing	2a or 2b	Descriptive Geometry	2
Drawing	3a	Topographical Drawing	1
Mechanics	103	Mechanics of Engineering	8
Geology	6b	Geology for Engineers	3
Astronomy	3	Spher. and Prac. Astronomy	4
Mechanical Engineering	131a	Engines and Boilers	2
Mechanical Engineering	124b	Mechanical Laboratory	1
Civil Engineering	101a or b	Elementary Surveying	2
Civil Engineering	104a	Higher Surveying	3
Civil Engineering	105b	Geodetic Surveying	3
Civil Engineering	111b	Railway Surveying	4
Civil Engineering	112b	Railway Engineering	4
Civil Engineering	121	Framed Structures	6
Civil Engineering	122a	Bridge Design	5
Civil Engineering	125b	Masonry Structures	4
Civil Engineering	126a	Concrete Structures	2
Civil Engineering	132b	Materials of Construction	2
Civil Engineering	133a	Testing Laboratory	1
Civil Engineering	141a	Hydraulic Machinery	2
Civil Engineering	145b	Water Supply	2
Civil Engineering	151a	Roads and Pavements	2
Civil Engineering	152a	Sanitary Engineering	2
Civil Engineering	161b	Specific. and Contracts	1
Civil Engineering	199b	Thesis	2
		Elective	16
			90

ELECTRICAL ENGINEERING.

H. B. SHAW, Professor; *A. E. FLOWERS, Assistant Professor; M. P. WEINBACH, E. W. KELLOGG, Instructors.

To furnish thorough training for Electrical Engineers, the individual studies have been very carefully selected and arranged, the technical subjects being varied somewhat from year to year to meet the demands of a rapidly developing profession.

Instruction is given by means of recitations, lectures, and laboratory work, thoroughly correlated, the idea being to present each subject to the student as a whole, and from all points of view. A feature of considerable interest is a Branch of the American Institute of Electrical Engineers. The department of Physics has charge of the special course in Electrical Measurements.

Attention is called to the studies, Steam Engineering, Kinematics, Hydraulic Motors, and Mechanical Laboratory under the direct charge of the department of Mechanical Engineering.

For the laboratory work in Electrical Engineering distinctively there are the following laboratories: Dynamo Laboratory for Direct and Alternating Currents, Standardizing Laboratory for the calibration of instruments, Laboratory for the testing of Materials used in Electrical Construction. These Laboratories are equipped with different types, makes, and sizes of motors, and generators, together with ammeters, volt-meters, and other instruments and accessories. Facilities for research work are continually being improved, each graduate being required to present a thesis evidencing original work.

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*On leave of absence, session of 1911-12.

Four Year Curriculum Leading to the Degree of Bachelor of Science in Electrical Engineering.

(The freshman year in each of the four year curricula has been discontinued.)

General Subject	No. of Course	Special Title	1st Sem.	2d Sem.
Sophomore Year				
Mathematics..........	5a	Differential Calculus......	4	0
Mathematics..........	6b	Integral Calculus..........	0	4
Economics............	2b	General Economics.........	0	5
Physics..............	3	General Physics..........	5	5
Shopwork............	3	Machine Work...........	2	2
Drawing.............	2a	Descriptive Geometry.....	2	0
Civil Engineering......	101a	Elementary Surveying.....	2	0
			15	16
Junior Year				
Mechanics...........	103	Mechanics of Engineering..	4	4
Physics..............	4	Electrical Measurements...	5	0
Electrical Engineering..	101a	Electrical Machinery......	5	0
Electrical Engineering..	102b	Adv. Electrical Machinery..	0	3
Electrical Engineering..	110b	Elementary Alt'g Currents.	0	5
Electrical Engineering..	106	Seminary...............	1	1
		Elective................	0	2
			15	15
Senior Year				
Mechanical Engineering	133	Prime Movers	3	3
Mechanical Engineering	123	Mechanical Laboratory....	1	1
Electrical Engineering..	111a	Adv. Alternating Currents.	5	0
Electrical Engineering..	120	Electrical Design.........	3	3
Electrical Engineering..	121	Electrical Engineering.....	3	3
Electrical Engineering..	199a or b	Thesis..................	0	2
		Elective................	0	3
			15	15

Three-Year Curriculum Leading to the Degree of Electrical Engineer.

For entrance to this Curriculum, two years of college work, the equivalent of 60 hours' credit in the College of Arts and Science, are required.

The degree of Electrical Engineer is awarded upon the completion of 90 hours' credit, including the following courses:

General Subject	No. of Course	Special Title	Hours Credit
Engineering	1a or 1b	Introduction to Engineer'g.	1
Drawing	1a or 1b	Mechanical Drawing	5
Drawing	2a or 2b	Descriptive Geometry	2
Manual Arts	1	Woodwork and Forging and Pattern Making	4
Manuel Arts	3	Machine Work	4
Civil Engineering	101a orb	Elementary Surveying	2
Mechanics	103	Mechanics of Engineering	8
Physics	104	Electrical Measurements	5
Mechanical Engineering	133	Prime Movers	6
Mechanical Engineering	123	Mechanical Laboratory	2
Electrical Engineering	101a	Electrical Machinery	5
Electrical Engineering	102b	Advanced Elec. Machinery.	3
Electrical Engineering	110b	Elementary Alt. Currents	5
Electrical Engineering	111a	Advanced Alt. Currents	5
Electrical Engineering	120	Electrical Design	6
Electrical Engineering	121	Electrical Engineering	6
Electrical Engineering	106	Seminary	2
Electrical Engineering	199	Thesis	2
		Elective	18
			90

MECHANICAL ENGINEERING.

H. W. HIBBARD, Professor; E. A. FESSENDEN, A. L. WESTCOTT, H. S. PHILBRICK, Assistant Professors; J. R. WHARTON, Instructor.

The study of the Science of Machinery is intended to fit young men to secure the greatest advantage from the practical experience which must precede, accompany or follow this study, and to enable them to be of earlier and greater responsible value in connection with Engineering Properties, as designers, in testing and inspection work, in engineering salemanship or other associated specialties, in power plant operation, in manufacturing and industrial management, and in improvement of existing or in creation of new properties.

The laboratory is equipped with steam, gas, and oil engines, steam turbine, water wheels, injectors, pumps, air compressors, fans, blowers, hoisting appliances, and apparatus for standardizing instruments. A large number of indicators, planimeters, thermometers, and water meters are used on tests, and the properties of oils, coals, transmission material, and gases are determined by apparatus for these purposes.

The work in the laboratory is to familiarize the student with the use and care of these machines as well as with the principles underlying the design, construction, and application. In equipping the laboratory it has been the aim to select apparatus which would bring the student in contact with most of the important forms or types of machines for developing and measuring power. It is also the intention to have him make most of the tests which a Mechanical Engineer is called upon to execute, and at the same time an attempt is made to have the student make original investigations on simple problems.

FOUR YEAR CURRICULUM LEADING TO THE DEGREE OF BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING.

(The freshman year of each of the four year curricula has been discontinued.)

General Subject	No. of Course.	Special Title	1st Sem.	2d Sem.
SOPHOMORE YEAR				
Mathematics..	5a	Differential Calculus	4	0
Mathematics..	6b	Integral Calculus	0	4
Physics..	3	General Physics..	5	5
Drawing..	2a	Descriptive Geometry	2	0
Economics	2b	Principles of Economics	0	2
Manual Arts	3	Machine Work	2	2
Civil Engineering	101a	Elementary Surveying..	2	0
Mechanical Engineering	101b	Elementary Mechanisms	0	2
			15	15
JUNIOR YEAR				
Mechanics	103	Mechanics of Engineering	4	4
Electrical Engineering	101a	Electrical Machinery	5	0
Electrical Engineering	103b	Alt. Current Machinery..	0	3
Mechanical Engineering	102a	Engineering Materials	1	0
Mechanical Engineering	103b	Elementary Machine Design	0	3
Mechanical Engineering	132	Steam Machinery	3	3
Mechanical Engineering	121	Elementary Mechanical Laboratory	2	2
			15	15
SENIOR YEAR				
Mechanical Engineering	135a	Heat Engines	3	0
Mechanical Engineering	136a	Steam Turbines	2	0
Mechanical Engineering	137b	Gas Engines	0	2
Mechanical Engineering	139b	Steam Engineering	0	5
Mechanical Engineering	104a	Advanced Machine Design.	3	0
Civil Engineering	124b	Mill Structures	0	2
Mechanical Engineering	122	Advanced Mechanical Lab.	2	2
Civil Engineering	161b	Specific. and Contracts	0	1
Mechanical Engineering	112b	Scientific Discipline	0	1
Mechanical Engineering	113a	Engineering Shopwork	2	0
		Elective	3	0
Mechanical Engineering	199b	Thesis	0	2
			15	15

THREE YEAR CURRICULUM LEADING TO THE DEGREE OF MECHANICAL ENGINEER.

For entrance to this curriculum, two years of college work, equivalent to 60 hours' credit in the College of Arts and Science, are required.

The degree of Mechanical Engineer is awarded upon the completion of 90 credit hours, including the following courses:

General Subject	No. of Course	Special Title	Hrs. Credit
Engineering	1a or 1b	Introduction to Engineering	1
Drawing	1a or 1b	Mechanical Drawing	5
Drawing	2a or 2b	Descriptive Geometry	2
Manual Arts	1	Woodwork, Forging and Pattern Making	4
Manual Arts	3	Machine Work	4
Civil Engineering	101a	Elementary Surveying	2
Mechanics	103	Mechanics of Engineering	8
Electrical Engineering	101a	Electrical Machinery	5
Electrical Engineering	103b	Alt. Current Machinery	3
Civil Engineering	124b	Mill Structures	2
Civil Engineering	161b	Specifications and Contracts	1
Mechanical Engineering	101b	Elementary Mechanisms	2
Mechanical Engineering	102a	Engineering Materials	1
Mechanical Engineering	103b	Elementary Machine Design	3
Mechanical Engineering	104a	Advanced Machine Design	3
Mechanical Engineering	121	Elementary Mechanical Lab	4
Mechanical Engineering	122	Advanced Mechanical Lab	4
Mechanical Engineering	132	Steam Machinery	6
Mechanical Engineering	135a	Heat Engines	3
Mechanical Engineering	136a	Steam Turbines	2
Mechanical Engineering	137b	Gas Engines	2
Mechanical Engineering	139b	Steam Engineering	5
Mechanical Engineering	113a	Engineering Shopwork	2
Mechanical Engineering	112b	Scientific Discipline	1
Mechanical Engineering	199b	Thesis	2
		Elective	13
			90

CHEMICAL ENGINEERING.

The rapid development of the chemical industries and the ever increasing demand for engineers thoroughly trained in the fumdamental chemical subjects have led to the introduction of courses in Chemical Engineering. The curricula outlined are designed to give a broad and thorough training in general engineering subjects, and in theoretical and applied chemistry. Instruction in chemistry continues through the whole length of the course. The general principles of physical science are further emphasized by extended courses in mathematics, physics, and mechanics.

The curricula aim to implant in the student a scientific method of work. Instruction is given by means of recitations, lectures, laboratory work, and conferences. The electives enable the student to give some attention to specialization, but the prime object of the course is to produce a broadly trained chemical engineer.

FOUR YEAR CURRICULUM LEADING TO THE DEGREE OF BACHELOR OF SCIENCE IN CHEMICAL ENGINEERING.

(The freshman year in each of the four curricula has been discontinued.)

General Subject	No. of Course	Special Title	1st Sem.	2d Sem.
SOPHOMORE YEAR				
Mathematics	5a	Differential Calculus	4	0
Mathematics	6b	Integral Calculus	0	4
Physics	3	General Physics	5	5
Chemistry	111	Organic Chemistry	3	3
Chemistry	121	Quantitative Analysis	3	3
			15	15
JUNIOR YEAR				
Mechanics	103	Mechanics of Engineering	4	4
Chemistry	131	Physical Chemistry	3	3
Electrical Engineering	101a	Electrical Machinery	5	
Electrical Engineering	103b	Alt. Current Machinery	0	3
Drawing	2b	Descriptive Geometry	0	2
Mechanical Engineering	101b	Elementary Mechanisms	0	2
Chemistry	122a	Technical Analysis	3	0
			15	14
SENIOR YEAR				
Mechanical Engineering	133	Prime Movers	3	3
Mechanical Engineering	123	Mechanical Laboratory	1	1
Physics	104a	Electrical Measurements	5	0
Mechanical Engineering	103b	Machine Design	0	3
Economics	2a	Principles of Economics	2	0
Chemistry	....	Thesis	0	2
		Elective	4	6
			15	15

Three Year Curriculum Leading to the Drgree of Chemical Engineer.

For entrance to this curriculum two years of college work, the equivalent of 60 hours' credit in the College of Arts and Science is required.

The degree of Chemical Engineer is awarded upon the completion of 90 hours' credit, including the following courses:

General Course	No. of Course	Special Title	Hrs. Credit
Drawing	1a or 1b	Mechanical Drawing	5
Drawing	2a or 2b	Descriptive Geometry	2
Mechanical Engineering	101b	Elementary Mechanisms	2
Mechanics	103	Mechanics of Engineering	
Electrical Engineering	101a	Electrical Machinery	8
Electrical Engineering	103b	Alt. Current Machinery	3
Mechanical Engineering	133	Prime Movers	6
Mechanical Engineering	123	Mechanical Laboratory	2
Physics	104a	Electrical Measurements	5
Mechanical Engineering	103b	Elemen. Machine Design	3
Chemistry	27a or b	Qualitative Analysis	5
Chemistry	111	Organic Chemistry	6
Chemistry	121	Quantitative Analysis	6
Chemistry	131	Physical Chemistry	6
Chemistry	122a	Technical Analysis	3
Chemistry	141aorb	Industrial Chemistry	3
		Thesis	2
		Elective	18
			90

For further information in regard to the School of Engineering, address

H. B. SHAW,
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For catalogue of the University and for special circulars of the Graduate School, College of Arts and Science, College of Agricultururs, School of Education, School of Law, School of Medicine, School of Engineering, and School of Journalism, address

MAILING CLERK,
University of Missouri,
Columbia, Missouri.

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ANNOUNCEMENT
OF THE
SCHOOL OF ENGINEERING
1913-1914

UNIVERSITY OF MISSOURI
COLUMBIA, MISSOURI
September, 1913

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THE MODERN ENGINEER.

In the year 1828 the Institution of Civil Engineers was organized in London. In the charter of the Institution, Civil Engineering was defined as the "art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states, both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation and docks for internal intercourse and exchange, and in the construction of harbors, moles, breakwaters and light houses, and in the art of navigation by artificial power for the purpose of commerce, and in the construction and adoption of machinery, and in the drainage of cities and towns."

For many years this definition has been a classic, regarded as expressing a definite view of the field covered by engineering practice. Many changes have occurred since the organization of the great Institution, and the enumeration of lines of work might be considerably modified and extended if it were to be written at the present time. To prepare a complete statement of what constitutes the entire field of engineering would be a large task, and it is only proposed here to give some brief account of the various fields of activity in which engineers may be engaged, and of the demands of practice upon the modern engineer.

HISTORICAL SKETCH.

Previous to the middle of the eighteenth century, the art of the engineer was applied almost exclusively to purposes of war. In a few instances public works intended for other purposes had been constructed, but the engineers were usually military officers and the works executed by soldiers. At about this period, however, a new class of engineers appeared, who concerned themselves with works of much the same character, but not military in purpose and not executed by soldiers. These men were known as "Civil Engineers" to distinguish them from the "Military Engineers." The increase in urban population and development of trade made a demand for public works, and for machinery, which soon caused the importance of the new profession to be recognized, and the number of its members to rapidly increase.

During this early period there was no division of the field of engineering into specialties, and civil engineers covered the whole range of works included in the definition. Amongst these early engineers were a number of very able men, who with but little training in the laws of science, and without precedents of practice to guide them, succeeded in accomplishing difficult engineering feats, and in establishing a safe and rational practice.

About the middle of the nineteenth century the industrial development which followed the invention of the steam engine had so widened the field of engineering practice, and so increased the demands upon the engineering profession that a single engineer could no longer cover the whole range of practice, and engineers began to devote their attention to more restricted lines of work. This soon resulted in dividing engineers into classes, each devoting its attention to a special field.

Engineering Building.

DIVISION INTO SPECIALTIES.

The demand for motor power and machinery for industrial enterprises and transportation caused many engineers to devote themselves exclusively to such work. These men were called "Mechanical Engineers" and were soon recognized as a distinct branch of the profession; the term civil engineer being still applied to those not primarily concerned with the production or operation of machinery.

Almost immediately following the separation of mechanical engineers into an independent profession, mining engineering became in the same way a separate branch. The demand for metals and coal consequent upon the industrial development already mentioned caused many engineers to devote their whole attention to the opening and operation of mines, and these were denominated "Mining Engineers," the term civil engineer being still used to include all those not belonging to the special branches.

Near the close of the nineteenth century the rapid discovery of methods of applying electricity to numerous uses, and the consequent immense development of electrical plants and appliances caused many men to devote their attention primarily to electrical work. These men were soon recognized as a distinct branch of the profession and called "Electrical Engineers."

More recently still, the development of chemical industries has created a demand for men who give their attention primarily to the construction and operation of plants for manufactures in which chemical processes play a leading part. These men are called "Chemical Engineers."

At the present time these five divisions of engineering practice are commonly recognized as distinct professions, or as distinct branches of the engineering profession. Schools of engineering commonly give separate curricula leading to degrees in each of these divisions, and while much of the training necessary to make an engineer is common to several or all of them, each engineer is usually recognized as belonging in one division, and limits his practice to his special branch.

The field of engineering practice is constantly widening. Great changes have taken place during the past few years in the standards of living of the people; urban populations have grown rapidly; manufacturing industries have greatly increased in number and become more diversified. The result of all this has been to make larger demands for the services of the engineer and to enlarge the scope of his activities. This growth has naturally caused a further subdivision of the various branches of engineering practice into narrower specialties, not usually recognized as separate professions, but each offering a sufficient opportunity for the exercise of the best endeavors of the men who follow them.

CIVIL ENGINEERING.

The term civil engineering is still often used in its original sense as covering all engineering not military, but commonly it is limited to those fields of practice not included in the other branches.

In the number of special fields of work included, it is much the broadest branch of engineering practice. It comprises:

Surveying, which in simple forms is used by all civil engineers, but which when applied in geodetic and topographic work may constitute a distinct field of practice.

Hydraulic Engineering, which includes the design and construction of harbors and docks; river improvements, canals, irrigation works, drainage and flood prevention, and water power projects.

Stream Measurement.

Sanitary Engineering, covering all works designed to protect the public health, such as water supply and water purification, sewerage and sewage disposal, and the disposal of garbage and refuse.

Highway Engineering, in which may be included both the maintenance and improvement of country roads and the construction and maintenance of city streets and pavements.

Railway Engineering, which deals with the design, construction and maintenance of all the works required for steam and electric railways.

Structural Engineering, which is concerned with the design and construction of bridges and of the structural features of large buildings that carry heavy loads, masonry and concrete structures, and heavy foundations.

General Construction, under which head may be included the execution of large works of construction, and the transportation and handling of heavy materials.

MECHANICAL ENGINEERING.

The term mechanical engineering is usually employed to designate the work of those engineers who have to do primarily with steam or other engines, machine tools, mill work and moving machinery in general. The lines of work included in the practice of a mechanical engineer may be:

Power Engineering, which consists in the design, construction, and operation of machines and plants for the generation of power. These may include steam, gas, oil, or other engines, with all the auxiliary appliances necessary to their operation, as well as the various methods of power distribution.

Design of Plants and Machinery for the Utilization of Power, requiring the study of special processes for which machinery may be required, and the adaptation of machines and arrangement of plants for purposes of economical production.

Shop Management, dealing with the control and management of shops in the operation of manufacturing plants.

Gas Engineering, covering the production, distribution, and utilization of gas for light, heat, and power purposes.

Railway Mechanical Engineering, consisting of the design, construction, and operation of rolling stock and other machinery, and of the shops required in the operation of railways.

ELECTRICAL ENGINEERING.

Engineers who are concerned mainly with the generation, transmission, or utilization of electrical energy are known as electrical engineers.

The past few years have seen a very great increase in the applications of electricity and the field of its usefulness is constantly widening. The special fields of most importance into which electrical engineering is divided are:

The design, construction and maintenance of telephone and telegraph lines.

The design and construction of machines and plants for the generation of electric power for various uses, including long distance transmission of electric power.

The construction and operation of machines and plants for the application of power in electric railways.

The utilization of electric energy for lighting purposes.

The application of electricity in the various chemical industries.

CHEMICAL ENGINEERING.

Engineers with special training in chemistry, who devote themselves to the development of the various chemical industries, are known as chemical engineers. This field of work is rapidly becoming a very large one on account of the many and varied industries which have been and are being developed.

RELATION OF ENGINEERS TO SOCIETY.

Attention has already been called to the great changes which have taken place in the status of the engineering profession in consequence of the development of industries, and the altered standards of living during the past century. These improved social conditions are for the most part the result of the work of the engineer; and the discoveries of modern science as applied in engineering practice have worked miracles for the better health, comfort, and convenience of modern life.

The invention and perfection of the steam engine was followed by the development of the factory system, making possible the supply of all kinds of manufactured articles at low cost. Then came the steamboat and railroad as methods of transportation, gas for illumination, and the telegraph for quick communication, and later all the various electric appliances, and in our cities water supply, paving, and sewage disposal. These things have changed the whole aspect of life, both in city and country, and have made the engineer absolutely essential to modern progress.

In view of the enormously important part which the engineer plays in the life of today, it is very necessary that he should be well trained and prepared to fully meet the responsibilities which rest upon him. In a state possessing immense natural resources, capable of development to a position of great wealth and power, and of providing occupation and homes for a large population, it is highly important that there be found a body of engineers able to direct this development in the best way that resources may be conserved, and improvements economically made. It is also important that the youth of the state have opportunity to make the best of themselves in whatever field of endeavor may be most attractive to them. It is therefore the duty of the School of Engineering to provide a thorough and adequate training for the young men who seek to be engineers, and to maintain a high standard of admission to the profession.

OPPORTUNITIES FOR ENGINEERS.

There are good opportunities in engineering practice for able and well trained men. Success in engineering depends upon hard application and experience. It is a strenuous occupation and holds forth no inducements to the man who is looking for an easy way to make a living. During the past few years there have usually been more openings for graduates than men to fill them. Entrance into engineering work has been easy for the man who has shown energy and ability as a student. After entrance into practice, the future of the engineer depends upon himself. There is opportunity of advancement for the man whose training has developed capacity for work, and who has interest in his work. The financial rewards are not usually great, although the more successful men have little cause for complaint. The true engineer has enthusiasm for his work. Opportunity for service is more to him than personal gain.

The largest field for engineering practice is in the service of various corporations. A few engineers, after obtaining considerable experience, are able to practice as independent consulting engineers, or as designing engineers for special lines of work. Many leave the technical side of engineering work and take up administrative positions, or become connected with the business side of industrial enterprises. Remuneration is commonly greater in such work than in the purely technical work of engineering design.

THE TRAINING OF ENGINEERS.

The education and training of most of the best modern engineers is accomplished by a course of study in a technical school, followed by experience in actual practice. Both are necessary to produce the well equipped engineer. The technical school gives a training in the sciences, and to some extent in the arts which underlie engineering practice. The object should be to develop power in the student to deal with problems involving mathematical and physical sciences, and to cultivate the faculty of independent thought in dealing with such problems.

The demands of modern engineering practice are for men of broad training. The man who is trained only in the technical side, however thorough may be his acquaintance with the sciences and however skillful he may be in working out the technical features of a design, can not achieve the highest success in his profession.

The idea is too prevalent among young men preparing themselves for the practice of engineering that nothing is of importance in such preparation which does not directly concern the technical features of their work, and they are even inclined at times to look with disdain upon work in other branches of engineering than their own.

This tendency is usually more marked among those in the earlier stages of preparation than later, when the student has reached a point where he begins to realize something of the real character of the work upon which he is about to enter. It is, therefore, important that those entering upon a course of training in preparation for professional work should be made to realize that breadth of training is necessary. The man who devotes himself exclusively to the technical work of his profession, may become highly skilled in such work. He may be a valuable man in the work with which he is familiar and highly appreciated for his technical skill by the broader man who is chief over him, but he will not be a chief himself. Men develop capacity for directing large affairs by acquiring intimate knowledge of their fellow men and learning how to deal with them. The training and experience of an engineer should give him capacity to direct large business projects, requiring judgment in matters pertaining to engineering. They should make him the logical man to control such enterprises. In order to be fitted for this work, a man must not only be expert in the technical details of the work, but he must have such knowledge of history and such an acquaintance with social and economic laws as to enable him to appreciate the relations of his work to the world about him.

He must, moreover, be able to formulate his ideas concisely and intelligibly, and to present them to others in an agreeable and convincing manner.

These matters should be seriously considered by the young man about to embark on a course of training which is to fit him for the practice of engineering, as well as by those having the direction of students looking forward to such practice. The leading technical schools are at present showing a tendency toward the requirement of broader training as preparation for admission into the engineering curricula, and the School of Engineering of the University of Missouri now requires that two years of work in the College of Arts and Science of this University, or in some other institution of the same character, shall precede admission into the School of Engineering. The technical work in the School of Engineering, then, occupies three years, making a total requirement of five years of college and university work. It is also recommended that, for students able to spend a longer time in preparation, the curriculum for a degree in Arts be completed. With proper arrangements of the college work, it is possible to cover the work for both degrees in six years.

PRELIMINARY TRAINING.

Students preparing to enter the School of Engineering should carefully plan their work with a view of obtaining thorough preparation in the sciences which necessarily precede the technical courses of the engineering curricula. For this purpose the college work should comprise mathematics, including trigonometry, algebra, ana-

Forge Shop.

lytical geometry and calculus, a course in general chemistry and a course in general physics. These courses are among the requirements for admission to our engineering school and their lack is a serious handicap to those entering without full credit in them. It is also desirable to have had some courses in shop work before entrance; this work preferably being done in the high school.

Every student should make a determined effort to obtain a good command of the English language, to speak and to write correctly, and to express himself with ease and clearness. This is a matter of the highest importance in any profession; and to an engineer who desires to rise above the routine work of a minor position, there can be no greater handicap than inability to use English readily and correctly.

In addition to these essentials, the student should include as much general training as possible in this preliminary work. He should study at least one modern European langage, and have some work in history and economics, while most of the courses commonly offered dealing with literature and social science will be of value to broaden the outlook upon life, and fit the student for his position as a member of society.

TECHNICAL TRAINING.

After the student enters the School of Engineering, his attention must necessarily be given mainly to the technical courses required for his professional training. These courses include instruction in the principles of the sciences which underlie engineering practice, and in the applications of these sciences to engineering problems, as well as in the methods employed by engineers in actual practice.

Several methods of instruction are employed depending in each instance upon the character of the work and the purpose with which it is given. Lectures, recitations, and quizzes are used for the purpose of giving a connected outline of the principles and applications of a science, or of the development of methods of practice in a given field. Problems in computation and design are employed to show the ways in which scientific principles are applied to engineering problems, to illustrate methods used in practice, and to develop the ability of the student to apply his scientific knowledge to questions arising in engineering design. Laboratory instruction is freely used to illustrate principles outlined in lecture courses, to familiarize the student with the construction and operation of machines or with the behavior of materials, and to develop capacity for independent investigation.

Efficient preparation for practice in any of the branches of engineering requires a broad training in the fundamental applications of science which underlie such practice, as well as some knowledge of the principles and methods of practice in the other fields of engineering. Narrow specialization is never allowable in undergraduate work. Engineering curricula, therefore, are made up mainly of required courses necessary to this fundamental training, but a certain amount of time is usually available for elective work in which a student may study more fully in one of the special lines of practice, or in which he may obtain a wider knowledge of fields of practice outside his own. The way in which elective time may be utilized to the best advantage varies with the preparation of the student and the purpose he has in view. The object should always be to secure symmetrical training, carrying preparation for the special field of practice as far as may be possible without sacrificing breadth of foundation.

THE SCHOOL OF ENGINEERING.

Instruction in engineering at the University of Missouri began in 1877, when a Chair of Civil Engineering was established in the College of Agriculture and Mechanic Arts, with a curriculum leading to the degree of Civil Engineer. Later, as the demand grew for technically trained men in the more restricted branches, instruction was offered in Mechanical and in Electrical Engineering. In 1907, the engineering departments were separated from the College of Agriculture and organized as an independent division of the University, known as the School of Engineering. This School now offers four curricula leading to degrees:

Civil Engineering.
Electrical Engineering.
Mechanical Engineering.
Chemical Engineering.

The object of the several curricula is to provide a broad, thorough and systematic training in the fundamental applications of the sciences which underlie the work of the engineering profession in its different branches, together with some opportunity for specialization by the proper selection of elective courses.

OFFICERS OF INSTRUCTION AND ADMINISTRATION.

ALBERT ROSS HILL, A. B., Ph. D., LL. D.,
President of the University.

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WILLIAM GEORGE BROWN, B. S., Ph. D.,
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SIDNEY CALVERT, B. S., A. M.,
Professor of Organic Chemistry.

LUTHER MARION DEFOE, A. B.,
Professor of Mechanics in Engineering.

EARL RAYMOND HEDRICK, A. B., A. M., Ph. D.,
Professor of Mathematics.

---

*Resigned as Dean of the Faculty of Engineering to become a member of the Public Service Commission of the State of Missouri. On leave of absence for one year as Professor of Electrical Engineering. A Professor of Electrical Engineering for 1913-14 will be appointed.

HERBERT WADE HIBBARD, A. B., A. M., M. E.,
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WILLIAM ALVAN MILLER, B. S. in C. E.,
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ROBERT WASHINGTON SELVIDGE, B. S., A. M.,
Associate Professor of Manual Arts.

WALTER SCOTT WILLIAMS, C. E.,
Associate Professor of Topographic Engineering.

JAMES ANDREW GIBSON, A. B., M. A.,
Assistant Professor of Analytical Chemistry.

HARVEY CLAYTON RENTSCHLER, A. B., A. M., Ph. D.,
Assistant Professor of Physics.

MENDEL PENCO WEINBACH, A. B., B. S. in E. E., A. M.,
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---

*On leave of absence, session 1912-13.

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Instructor in Mathematics.

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JAMES ROY WHARTON, B. S. in M. E., M. E.,
Instructor in Mechanical Engineering.

FREDERICK GUSTAV BECKMAN,
Assistant in Electrical Engineering.

BENJAMIN FRANKLIN CLARK,
Assistant in Manual Arts.

LEE ERNEST HILDEBRAND, B. S.,
Research Assistant, Engineering Experiment Station.

ALEXANDER WATTS McCOY, C. E.,
Research Assistant, Engineering Experiment Station.

CLEO FRANK CRAIG,
Problem Reader in Mechanics.

HERON ALBERT FOUNTAIN,
Student Assistant in Electrical Engineering.

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*On leave of absence, session 1912-13.

SIDNEY MARVIN HARDAWAY,
Student Assistant in Electrical Engineering.

FRANCIS IVAN KEMP,
Student Assistant in Mechanical Engineering.

GEORGE FRANK KLEIN,
Student Assistant in Mechanical Engineering.

ROBERT RUNGE,
Problem Reader in Mechanics.

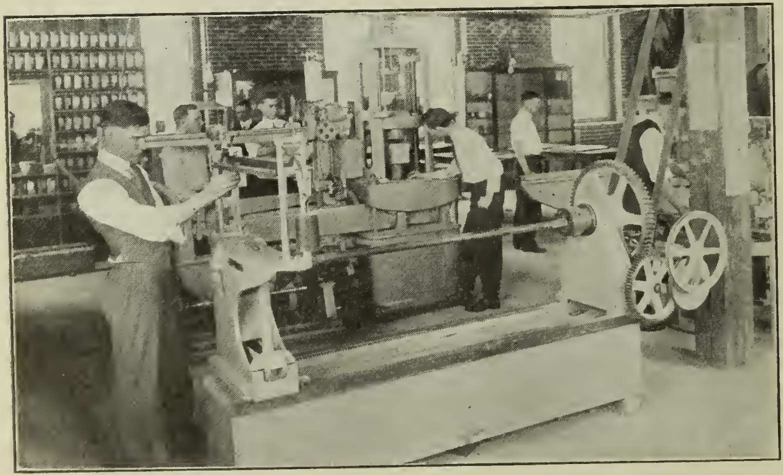
WILLIAM CHARLES THOMPSON,
Student Assistant in Manual Arts.

BUILDINGS AND EQUIPMENT.

The Departments of Electrical and Mechanical Engineering occupy the main Engineering Building and the Department of Civil Engineering about half of Switzler Hall. The work in chemistry required of students in Chemical Engineering is given in the Chemistry Building.

The main engineering laboratories are in the Engineering Annex in the rear of the Engineering Building. Shop work is conducted in a building recently erected for the purpose.

Civil Engineering. The laboratory for testing materials is in charge of the Department of Civil Engineering. The equipment includes several vertical testing machines with all the necessary accessories for tension, compression and transverse tests on the ordinary engineering materials, iron, steel, cement, concrete, brick, etc.; a beam testing machine; a torsion machine; impact and abrasion machines. There is also a complete equipment for all the standard tests upon hydraulic cement.



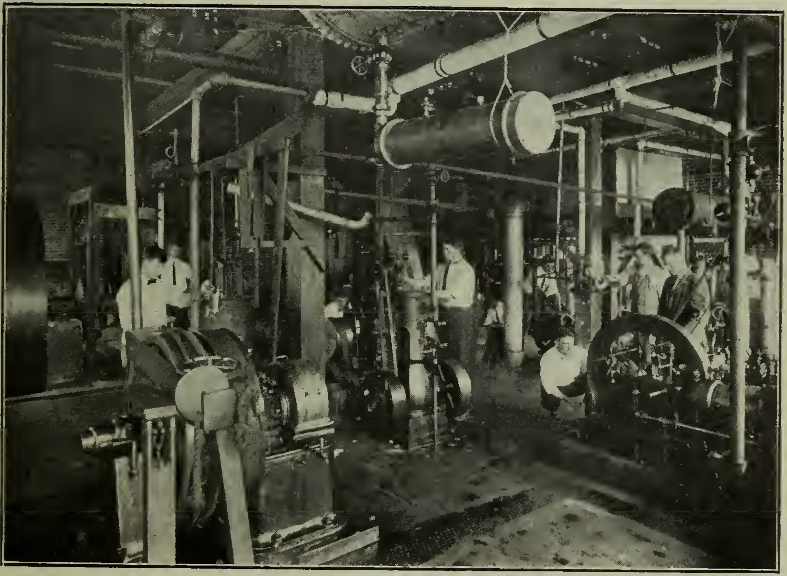
Materials Testing Laboratory.

The road materials laboratory contains the necessary machines for making complete tests upon stone for road purposes, a standard rattler for paving brick tests, and the apparatus required in investigating bituminous road materials.

There is a good collection of surveying instruments, including the instruments used in ordinary field practice and those necessary for precise surveying and geodetic work.

Stream gauges, with a dam and weirs on streams near Columbia, afford opportunity for field study of water supply problems, while practice in hydrographic surveying and stream measurement is obtained by a trip to a river in the neighborhood.

Mechanical Engineering. The mechanical engineering laboratory contains several different types of steam engines, a small steam turbine with a superheater, condensers, gas engines, reciprocating and centrifugal pumps, a number of fans, blowers, and heating coils for work on ventilation and heating, and a variety of other machinery. Much attention is paid to the study of fuels of all kinds and complete standard apparatus for determining the analysis and calorific value of coals and gases is provided. The laboratory is supplied with the usual equipment of indicators, gauges, water and gas meters, scales, and other necessary accessories.



Mechanical Engineering Laboratory.

The central power plant of the University is used for conducting boiler tests under actual operating conditions. Considerable attention is given to the study of refrigeration and several small ice and cold storage plants belonging to the University are available for tests. A local privately owned plant is also sometimes used.

Negotiations are now in progess leading to the purchase of a high grade lathe completely equipped for use in connection with courses in shop efficiency. It will be used to make production tests to determine the proper kinds of tools and the best cutting speeds to use in making machine parts.

Electrical Engineering. The electrical engineering laboratory contains direct and alternating current generators and motors of the common types met with in practice, and all the instruments necessary to make complete tests of their operation. Besides several low ratio transformers used in routine exercises, the laboratory has a 10,000 volt transformer for testing dielectric strengths and one of 40,000 volts for high tension experiments. A set of Edison cells and one of chloride cells are available for experiments on storage batteries.

Electrical Engineering Laboratory.

A low voltage motor-generator set is provided for general electro-chemical processes, such as electro-plating with gold, silver, nickel, and copper. One large and several small electric furnaces are used for demonstrations of the electric processes involved in the production of carborundum, graphite, emery, calcium carbide, ferro-alloys, etc.

The telephone equipment comprises a demonstration board showing all the apparatus and operations involved in a connection through two offices. For experiments in telephone transmission there is a high frequency generator and an artificial line which is electrically equivalent to fifty miles of underground wire.

The laboratory also has a quadruplex telegraph set.

Chemical Engineering. In addition to the laboratories in general chemistry, there are separate laboratories for the other fundamental courses in chemistry required in the chemical engineering curriculum. The general analytical laboratory offers facilities for work in qualitative and quantitative analysis. Special work in the technical analysis of fuels, water, gas, and commercial products is to be given in smaller laboratories equipped especially for these lines of work. Two laboratories are available for general work in organic chemistry, and more advanced work along organic lines is provided for in a furnace room and a laboratory for the preparation of organic compounds. The laboratory in physical chemistry is equipped for work in electro-chemistry and measurements in radioactivity. Advanced students have an opportunity to pursue work in metallography. The electrical laboratories in the Engineering Building offer facilities for work in electroplating, storage battery engineering, and electrical processes.

The congested condition of the chemistry building will be somewhat relieved by the removal of the work in general chemistry to its new quarters in Schweitzer Hall. This expansion will permit the installation of several smaller laboratories for special lines of chemical work.

Library. The Engineering Library in the Engineering Building has about 4,500 standard engineering books. These have been very carefully selected and include the works of all of the best American and English engineering authors. About 100 periodicals are regularly received together with publications recording the transactions of the more important engineering societies.

Engineering students are permitted free access to the library shelves for reference and are encouraged to draw books for outside reading.

The general library of the University and the library of the State Historical Society together containing about 200,000 books and pamphlets are open to all students in the University.

ENGINEERING CURRICULA.

ENTRANCE.

The opinion is rapidly gaining ground that a liberal training in the fundamental sciences and in cultural subjects is essential to success in engineering. This University was the first of the state universities to recognize this to the extent of requiring two years of college work before entrance to the School of Engineering.

The requirements for admission to the School of Engineering are the satisfactory completion of (1) a four years' high school course or its equivalent, and (2) the first two years' work or sixty (60) hours' credit in the College of Arts and Science of the University of Missouri or its equivalent. This credit must include Inorganic Chemistry, 5 hours; Calculus, 8 hours; General Physics, 10 hours; students who do not present these credits for entrance must take such courses in addition to the courses in the engineering curricula.

It is desirable that students shall also have completed the elementary work in shop and drawing. Ten hours' credit in manual arts are accepted as part of the 60 hours' credit in the College of Arts and Science required for entrance.

Students entering the College of Arts and Science to prepare for entrance to the School of Engineering should so state when first enrolling in the University in order that their work may be arranged to include all of the specific subjects required for admission to the School of Engineering.

Students from other colleges or universities are admitted to the School of Engineering upon the same conditions as from the College of Arts and Science of this University provided the credits offered for entrance represent the equivalent of the training given by the College of Arts and Science. Much time can usually be saved in registration if these credits are determined in advance; address communications regarding entrance to the Dean of the University Faculty, University of Missouri, Columbia, Missouri.

Combined curricula covering six years' work enabling students to obtain both the A. B. and the engineering degree have also been arranged. These afford excellent opportunities for general cultural training together with an engineering education and students who can afford the additional year required are urged to take advantage of them.

Woodworking Shop.

The courses in engineering require that students be strong in mathematics and science. Those who are not strong in these lines are advised not to undertake work in engineernig.

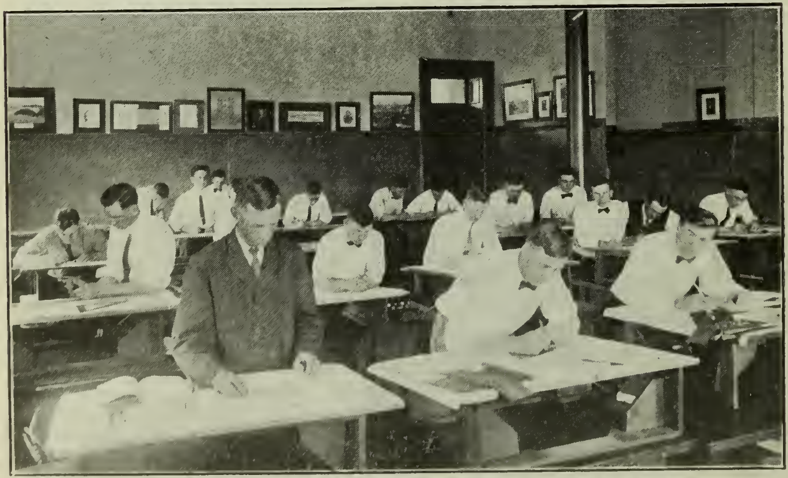
For a full statement of the requirements for entrance to the College of Arts and Science, see the annual catalogue of the University. This may be secured by addressing the Dean of the University Faculty, University of Missouri, Columbia, Missouri. For special information not found in the catalogue, address the Dean of the School of Engineering, University of Missouri, Columbia, Missouri.

CURRICULA.

There are four three-year curricula leading respectively to the degrees of Civil Engineer, Electrical Engineer, Mechanical Engineer, and Chemical Engineer. The completion of 90 credit hours as specified in the respective curricula is required for each of these degrees.

CIVIL ENGINEERING.

The field covered by this curriculum is wide, embracing topographical, railway, hydraulic, structural, municipal, and highway engineering. It is the aim to give a broad general training which may later serve as a foundation for the development of any special line under the general term, Civil Engineering.



A Class in Design.

The curriculum has, therefore, been arranged with the purpose of providing thorough training in those fundamental sciences and principles upon which the practice of the civil engineer is based, and also, in so far as practicable, of giving instruction in the special subjects which underlie the several branches. A number of subjects are made elective, with the object of permitting the student to select his more advanced work in one of the special divisions of civil engineering.

The degree of Civil Engineer is conferred upon the completion of 90 credit hours including the following courses:

General Subject.	No. of Course	Special Title.	Hours credit
Engineering	1a	Introduction to Engineering	1
Drawing	1a or 1b	Mechanical Drawing	5
Drawing	2a or 2b	Descriptive Geometry	2
Drawing	3a	Topographical Drawing	1
Mechanics	103	Mechanics of Engineering	8
Geology	6b	Geology for Engineers	3
Astronomy	3	Spher. and Prac. Astronomy	4
Mechanical Engineering	131a	Engines and Boilers	2
Mechanical Engineering	124b	Mechanical Laboratory	1
Civil Enginering	102a or 102b	Elementary Surveying	3
Civil Engineering	104b	Higher Surveying	3
Civil Engineering	105b	Geodetic Surveying	3
Civil Engineering	111a	Railway Surveying	5
Civil Engineering	112b	Railway Engineering	3
Civil Engineering	121	Framed Structures	6
Civil Engineering	122a	Bridge Design	5
Civil Engineering	125b	Masonry Structures	3
Civil Engineering	126a	Concrete Structures	2
Civil Engineering	132b	Materials of Construction	3
Civil Engineering	133a	Testing Laboratory	1
Civil Engineering	141a	Water Power	3
Civil Engineering	142b	Water Supply	2
Civil Engineering	151a	Roads and Pavements	2
Civil Engineering	152b	Sanitary Engineering	2
Civil Engineering	191b	Specific. and Contracts	1
Civil Engineering	199	Thesis	3
		Elective	13
			90

A Surveying Party.

ELECTRICAL ENGINEERING.

The curriculum in Electrical Engineering is intended to prepare students for electrical designing, manufacturing, contracting, and for the installation and management of central and isolated electric light stations, power plants and electric railways. It is planned to furnish insight into and appreciation of the complex problems requiring solution by electrical engineers, while giving thorough, broad training.

The technical work consists of the theory and principles of electricity and magnetism; electrical measurements; calibration of instruments; tests of all kinds; design and construction; study of problems in the generation, transmission, distribution, and utilization of electrical energy.

Special attention is paid to alternating current phenomena.

The degree of Electrical Engineer is conferred upon the completion of 90 hours' credit, including the following courses:

General Subject.	No. of Course.	Special Title.	Hrs. Credit
Engineering	1a	Introduction to Engineering	1
Drawing	1a or 1b	Mechanical Drawing	5
Drawing	2a or 2b	Descriptive Geometry	2
Manual Arts	1a or 1b	Woodwork and Forging	2
Manual Arts	2a or 2b	Pattern Making	2
Manual Arts	3	Machine Work	4
Civil Engineering	102a or 102b	Elementary Surveying	3
Mechanics	103	Mechanics of Engineering	8
Physics	104	Electrical Measurements	5
Mechanical Engineering	133	Prime Movers	6
Mechanical Engineering	123	Mechanical Laboratory	2
Electrical Engineering	101a	Electrical Machinery	5
Electrical Engineering	102b	Advanced Electrical Machinery..	3
Electrical Engineering	110b	Elementary Alternating Currents	5
Electrical Engineerng	111a	Advanced Alternating Currents..	5
Electrical Engineering	120	Electrical Design	6
Electrical Engineering	121	Electrical Engineering	6
Electrical Engineering	106	Seminar	2
Electrical Engineering	199	Thesis	3
		Elective	15
			90

MECHANICAL ENGINEERING.

The curriculum in Mechanical Engineering is intended to fit young men to secure the greatest advantage from the practical experience which must precede, accompany or follow such a study of the applications of the sciences in a profession; and to enable them to be of earlier and greater responsible value in connection with engineering properties,—as designers, installing engineers, in testing and inspection work, in engineering salesmanship or other associated specialties, in power plant operation, in manufacturing, in efficiency improvement, and in the conception, organizing and direction of extended mechanical industrial enterprises.

The degree of Mechanical Engineer is conferred upon the completion of 90 credit hours, including the following courses:

General Subject.	No. of Course.	Special Title.	Hours Credit
Engineering	1a	Introduction to Engineering	1
Drawing	1a or 1b	Mechanical Drawing	5
Drawing	2a or 2b	Descriptive Geometry	2
Manual Arts	1a or 1b	Woodwork and Forging	2
Manual Arts	2a or 2b	Pattern Making	2
Manual Arts	3	Machine Work	4
Mechanical Engineering	101b	Elementary Mechanisms	2
Mechanics	103	Mechanics of Engineering	8
Mechanical Engineering	102a	Engineering Materials	1
Mechanical Engineering	132	Steam Machinery	6
Mechanical Engineering	121	Elementary Mechanical Laboratory	4
Mechanical Engineering	103b	Elementary Machine Design	3
Electrical Engineering	101a	Electrical Machinery	5
Electrical Engineering	103b	Alternate Current Machinery	3
Civil Engineering	101a	Elementary Surveying	2
Mechanical Engineering	135a	Heat Engines	3
Mechanical Engineering	122	Advanced Mechanical Laboratory	4
Mechanical Engineering	104a	Advanced Machine Design	3
Mechanical Engineering	113a	Engineering Shopwork	2
Mechanical Engineering	136a	Steam Turbines	2
Mechanical Engineering	137b	Gas Engines	2
Civil Engineering	124b	Mill Structures	2
Civil Engineering	191b	Specifications and Contracts	1
Mechanical Engineering	139b	Steam Engineering	5
Mechanical Engineering	112b	Scientific Discipline	1
Mechanical Engineering	199	Thesis	3
		Elective	12
			90

CHEMICAL ENGINEERING.

The rapid development of the chemical industries and the ever increasing demand for engineers trained in the fundamental chemical subjects have led to the introduction of courses in Chemical Engineering. The curriculum outlined is designed to give a broad and thorough training in general engineering subjects, and in thoretical and applied chemistry. Instruction in chemistry continues through the whole length of the curriculum. The general principles of physical science are further emphasized by extended courses in mathematics, physics, and mechanics.

The curriculum aims to implant in the student a scientific method of work. Instruction is given by means of recitations, lectures, laboratory work, and conferences. The electives enable the student to give some attention to specialization, but the prime object is to produce a broadly trained chemical engineer.

The degree of Chemical Engineer is conferred upon the completion of 90 hours' credit, including the following courses:

General Course.	No. of Course.	Special Title.	Hrs. Credit
Engineering	1a	Introduction to Engineering	1
Drawing	1a or 1b	Mechanical Drawing	5
Drawing	2a or 2b	Descriptive Geometry	2
Mechanical Engineering	101b	Elementary Mechanisms	2
Mechanics	103	Mechanics of Engineering	8
Electrical Engineering	101a	Electrical Machinery	5
Electrical Engineering	103b	Alt. Current Machinery	3
Mechanical Engineering	133	Prime Movers	6
Mechanical Engineering	123	Mechanical Laboratory	2
Physics	104a	Electrical Measurements	5
Mechanical Engineering	103b	Elemen. Machine Design	3
Chemistry	27a or b	Qualitative Analysis	5
Chemistry	111	Organic Chemistry	6
Chemistry	121	Quantative Analysis	6
Chemistry	131	Physical Chemistry	6
Chemistry	122a	Technical Analysis	3
Chemistry	141a or b	Industrial Chemistry	3
		Thesis	3
		Elective	16
			90

STATEMENT OF COURSES.

Courses designated by a number with the letter **a** attached, thus: 100a, are given the first semester only. Those designated by a number with the letter **b** attached, thus: 100b, are given the second semester only. Those designated merely by a number are continuous courses and are given both semesters. Courses numbered 200 and above are strictly graduate in character. **Arabic numerals in parenthesis indicate the number of hours credit a semester.** A full description of courses will be found in the annual catalogue which may be obtained by addressing the Dean of the University Faculty, University of Missouri, Columbia, Missouri.

A schedule of recitations, lectures and laboratory work may be had upon application to the Registrar after August 1st.

ENGINEERING.

1a. **Introduction to Engineering.** (1). Mr. Hibbard.

10a or 10b. **Elementary Automobile Engineering.** (no credit). Mr. Clark.

CIVIL ENGINEERING.

Topographical Engineering

101a or 101b. **Elementary Surveying.** (2). Mr. Williams.
102a or 102b. **Elementary Surveying.** (3). Mr. Williams.
104b. **Higher Surveying.** (3). Mr. Williams.
105b. **Geodetic Surveying.** (3). Mr. Williams.
106a. **City Planning.** (2). Mr. Williams.
201. **Geodesy and Precise Surveying.** (-). Mr. Williams.

Railway Engineering

111b. **Railway Surveying.** (5). Mr. Miller.
112b. **Railway Engineering.** (3). Mr. Miller.
114a. **Railway Maintenance.** (3). Mr. Miller.
115a. **Railway Yards and Terminals.** (2). Mr. Miller.
116b. **Signaling and Interlocking.** (2). Mr. Miller.
211. **Railway Engineering.** (-). Mr. Miller.

Structural Engineering

121. **Framed Structures.** (3). Mr. Hyde.
122a. **Bridge Design.** (5). Mr. Hyde.
123b. **Higher Structures.** (3). Mr. Hyde.
124b. **Mill Structures** (2). Mr. Hyde.
125b. **Masonry Structures.** (3). Mr. Spalding.
126a. **Concrete Structures.** (2). Mr. Spalding.
221. **Bridge Engineering.** (-). Mr. Hyde.
222. **Concrete Structures.** (-). Mr. Spalding; Mr. Hyde.

Materials of Construction

132b. **Materials of Construction** (3). Mr. Spalding; Mr. Roberts.
133a. **Testing Laboratory.** (1). Mr. Roberts.
134b. **Testing Road Materials.** (1). Mr. Roberts.

Hydraulic Engineering

141a. **Water Power.** (3). Mr. Rodhouse.
142b. **Water Supply.** (2). Mr. Rodhouse.

143a. **Irrigation and Drainage.** (2). Mr. Rodhouse.
144b. **Rivers and Canals.** (2). Mr. Rodhouse.
145b. **Hydraulic Design.** (2). Mr. Rodhouse.
241. **Hydraulic Engineering.** (-). Mr. Rodhouse.

Municipal Engineering

151a. **Roads and Pavements.** (2). Mr. Spalding.
152b. **Sanitary Engineering.** (2). Mr. Spalding.
153a. **Sewerage.** (2). Mr. Rodhouse.
154b. **Municipal Sanitation.** (2). Mr. Spalding.
155a. **Highway Engineering.** (2). Mr. Spalding.
156b. **Highway Structures.** (2). Mr. Hyde.
157b. **Sanitary Design.** (2). Mr. Spalding.
251. **Sanitary Engineering.** (-). Mr. Spalding.

General

191b. **Specifications and Contracts.** (1). Mr. Spalding.
199. **Thesis.** (1, first semester; 2, second semester).

ELECTRICAL ENGINEERING.

101a. Electrical Engineering (5). Mr. Weinbach.
102b. Advanced Electrical Machinery. (3). Mr. Weinbach.
103b. Alternating Current Machinery. (3). Mr. Weinbach.
106. Seminar. (1). Mr. Kellogg.
110b. Alternating Currents. (5). Mr. Kellogg.
111a. Advanced Alternating Currents. (5). Mr. Kellogg.
120. Electrical Design. (3).
121. Electrical Engineering. (3).
122. Central Station Management and Operation. (3).
131a. Electric Motors. (2).
132a. Storage Batteries. (2). Mr. Weinbach.
133a. Illumination. (3).
134b. Telephony and Telegraphy. (2). Mr. Kellogg.
140b. Central Station Practice and Design. (2). Mr. Kellogg.
141b. Electric Railways. (3).
142b. Transmission. (3).
143b. Electrical Processes. (2). Mr. Weinbach.
144b. Elementary Research. (2).
199. Thesis. (1) and (2).
221. Advanced Design. (-).
222. Electric Railway Engineering.
223. Electrical Engineering Economics.
224. Research.
225. Thesis.

MECHANICAL ENGINEERING.

Design

101b. **Elementary Mechanisms.** (2). Mr. Hibbard.

102a. **Engineering Materials.** (1). Mr. Hibbard.

103b. **Elementary Machine Design.** (3). Mr. Hibbard.

201. **Special Machine Design.** (-). Mr. Fessenden.

Shop Management

111b. **Engineering Office Work.** (1). Mr. Hibbard.

112b. **Scientific Discipline.** (1). Mr. Hibbard.

113a. **Engineering Shopwork.** (2). Mr. Hibbard.

113b. **Engineering Shopwork.** (2). Mr. Hibbard.

114a or 114b. **Hoisting and Conveying Machinery.** (2). Mr. Westcott.

115b. **Plants and Processes.** (2). Mr. Fessenden.

Testing and Experimental Engineering

121. **Elementary Mechanical Laboratory.** (2). Mr. Westcott.

122. **Advanced Mechanical Laboratory.** (2). Mr. Westcott.

123. **Mechanical Laboratory,** for Electrical and Chemical Engineering students. (1). Mr. Westcott.

124b. **Mechanical Laboratory,** for students in Civil Engineering. (1). Mr. Wharton.

224. **Special Mechanical Laboratory.** (-). Mr. Hibbard, Mr. Westcott or Mr. Wharton.

Power Engineering

131a. **Engines and Boilers.** (2). Mr. Wharton.

132. **Steam Machinery.** (3). Mr. Fessenden.

133. **Prime Movers.** (3). Mr. Fessenden, Mr. Wharton.

134a. **Valve Gears.** (2). Mr. Fesesnden.

135a. **Heat Engines.** (3). Mr. Wharton.

136a. **Steam Turbines.** (2). Mr. Fessenden.

137b. **Gas Engines.** (2). Mr. Wharton.

138a. **Gas Producers.** (2). Mr. Wharton.

139b. **Steam Engineering.** (5). Mr. Fessenden.

141b. **Boiler Design.** (2). Mr. Fessenden.

231. **Power Generation.** (-). Mr. Hibbard, Mr. Wharton.

236. **Advanced Steam Turbine Design.** (-). Mr. Fessenden.

Power Applications

151b. **Refrigeration.** (3). Mr. Wharton.

152a. **Ventilation and Heating.** (2). Mr. Fessenden.

153a. **Water Motors.** (2). Mr. Wharton.

154b. **Pumping Machinery.** (2). Mr. Wharton.

255. **Power Transmission.** (-). Mr. Hibbard.

Railway

161. **Railway Mechanical Engineering.** (-). Mr. Hibbard.

162. **Locomotive Design.** (-). Mr. Hibbard.

261. **Railway Shops and Locomotive Terminals.** (-). Mr. Hibbard.

General

171a or 171b. **Technical Literature.** (1). Mr. Hibbard.

199. **Thesis.**

299. **Thesis.**

CHEMISTRY.

27a and 27b. **Qualitative Analysis.** (5). Mr. Gibson.

111. **Organic Chemistry.** (3). Mr. Calvert.

112a and 112b. **Preparation of Organic Compounds.** (2) or (3). Mr. Calvert.

113a and 113b. **Preparation of Organic Compounds and Organic Analysis.** (3), (4) or (5). Mr. Calvert.

121. **Quantitative Chemical Analysis.** (3). Mr. Gibson.

122a. **Technical Analysis.** Gas, Water and Fuel. (3). Mr. Gibson or Mr. Brown.

123b. **Technical Analysis.** Inorganic commercial products. (3). Mr. Gibson or Mr. Brown.

125a. **Quantitative Organic Analysis.** (3). Mr. Calvert.

126b. **Quantitative Organic Analysis.** (3). Mr. Calvert.

127. **Advanced Qualitative Analysis.** (2). Mr. Gibson.

131. **Physical Chemistry.** (3), (4) or (5). Mr. Schlundt.

133. **Electro-Chemistry.** (3), (4) or (5). Mr. Schlundt.

135a or 135b. **Radioactivity.** (3). Mr. Schlundt.

141a. **Industrial Chemistry.** (3). Mr. Brown.

142b. **Industrial Chemistry.** (2) or (3). Mr. Brown.

151a or 151b. **History of Chemistry.** (3).

200. **Chemistry of the Rare Earths.** (3). Mr. Brown.

211a and 211b. **Advanced Organic Chemistry.** (2) or (3). Mr. Calvert.

221. **Advanced Quantitative Analysis.** (-). Mr. Gibson.

231. **Mathematical Chemistry.** (2). Mr. Morlan.

232a and 232b. **Advanced Physical Chemistry.** (-). Mr. Schlundt.

271. **Research.**

MECHANICS.

101. **Elementary Mechanics.** (2). Mr. Defoe.

103. **Mechanics of Engineering.** (4). Mr. Defoe.

104. **Elasticity.** (3). Mr. Defoe.
109. **Hydrodynamics.** (-). Mr. Defoe.
120. **Advanced Mechanics.** (-) Mr. Defoe.

MANUAL ARTS.

1a or 1b. **Woodwork and Forging.** (1 or 2). Mr. Clark.
2a or 2b. **Pattern Making.** (2). Mr. Clark.
3. **Machine Work.** (2). Mr. Selvidge.
4. **Advanced Machine Work.** (2). Mr. Selvidge.

MECHANICAL DRAWING.

1a and 1b. **Mechanical Drawing.** (5). Mr. Rodhouse; Mr. Welch.

2a and 2b. **Descriptive Geometry.** (2). Mr. Welch; Mr. Rodhouse.

7a and 7b. **Mechanical Drawing.** (3). Mr. Rodhouse; Mr. Welch.

3a. **Topographical Drawing.** (1). Mr. Welch.

4a and 4b. **Topographical Drawing.** (3). Mr. Rodhouse; Mr. Welch.

6b. **Advanced Lettering.** (1). Mr. Welch.

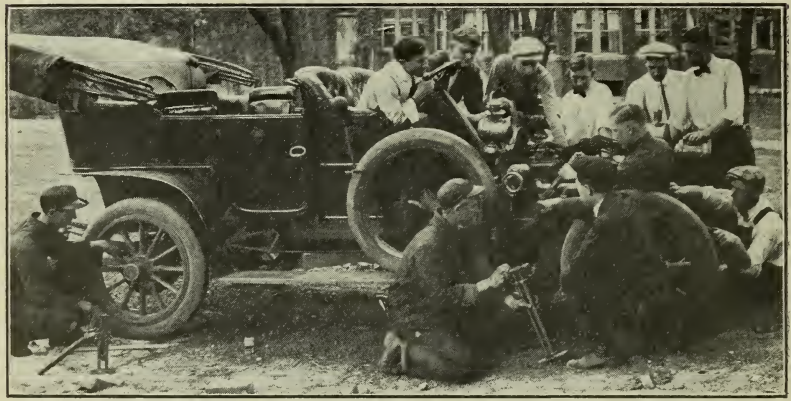
8a and 8b. **Engineering Drawing** (2). Mr. Rodhouse; Mr. Welch.

COURSES IN OTHER DIVISIONS.

Courses for engineering students in astronomy, mathematics, and physics are announced under the statement of courses, College of Arts and Science, in the annual catalogue of the University.

AUTOMOBILE ENGINEERING.

The rapid development of the automobile has created a demand in the engineering and designing department of the automobile industries for technically trained men with some knowledge of the automobile. To meet this demand some courses in automobile engineering have been arranged. At present these are elementary in character, consisting of series of carefully planned lectures and recitations correlated with a considerable amount of laboratory work. Three automobiles have been purchased and a garage built to serve as an automobile laboratory. The cars are dissected, thoroughly examined and re-assembled by the students and some practice in driving is given. Power tests of the cars are made through the cooperation of the Electrical Engineering Laboratory. Vulcanizing outfits and other accessories are available for practice work on tires.



A Class in Automobile Engineering.

THE ENGINEERING EXPERIMENT STATION.

The Engineering Experiment Station of the University of Missouri was established by order of the Board of Curators, July 1, 1909.

The object of the Station is to be of service to the people of the State of Missouri.

First: By investigating such problems in engineering lines as appear to be of the most direct and immediate benefit and publishing these studies and information in the form of bulletins.

Second: By research of importance to the manufacturing and industrial interests of the State and to engineers.

The staff of the Station consists at present of a Director and research assistants together with a number of teachers who have undertaken research under the direction of the Station.

Suggestions as to problems to be investigated, and inquiries will be welcomed.

Bulletins have been published as follows:

Vol. 1, No. 1, *Acetylene for Lighting Country Homes*, by J. D. Bowles, Research Assistant, 1909-10.

Vol. 1, No. 2, *Water Supply for Country Homes*, by K. A. McVey, Research Assistant, 1909-10.

Vol. 1, No. 3, *Sanitation and Sewage Disposal for Country Homes*, by W. C. Davidson.

Vol. 2, No. 1, *The Heating Value and Proximate Analysis of Missouri Coals*, by C. W. Marx and Paul Schweitzer. (A reprint.)

Vol. 2, No. 2, *Friction and Lubrication Testing Apparatus*, by Alan E. Flowers.

Vol. 2, No. 3, *Tests of Road Materials of Missouri*, by W. S. Williams and Warren Roberts.

Vol. 3, No. 1, *The Use of Metal Conductors to Protect Buildings from Lightning*, by E. W. Kellogg.

Vol. 3, No. 2, *Firing Tests on Missouri Coal*, by H. N. Sharp, Research Assistant, 1911-12.

Vol. 3, No. 3, *A Report on Steam Boiler Trials Under Operating Conditions*, by A. L. Westcott.

The following studies are now in progress:

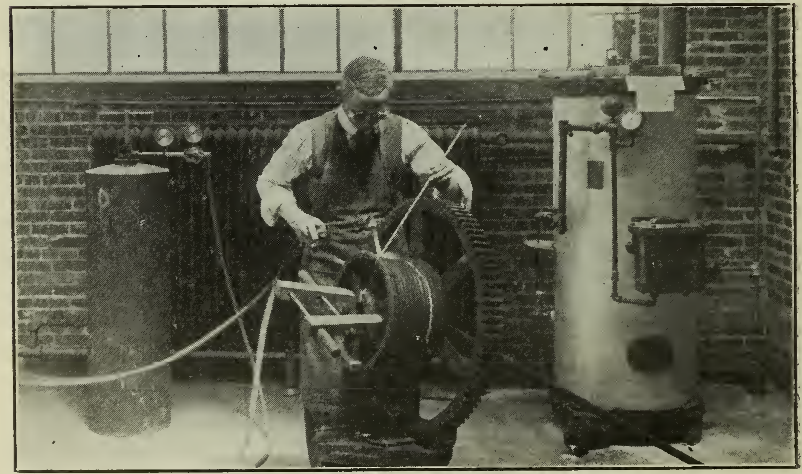
Tests of Lubricants,
Coal Testing,
Deep Wells and Deep Well Pumping,
The Artesian Waters of Missouri,
Insulating Materials,

Rural Distribution of Electricity,
Boiler Operation,
Water Power of Missouri,

besides a number of detailed studies of Materials and Processes and Investigations of Missouri's Natural Resources.

A Standardizing Laboratory has been established and part of the apparatus is now available.

Any resident of the State may on request obtain bulletins as issued or if particularly interested, may be placed on the regular mailing list. Address the Engineering Experiment Station, University of Missouri, Columbia, Missouri.



Oxy-Acetylene. Welding.

STUDENT ACTIVITIES.

Notwithstanding a very strong **esprit de corps** among the students of the School of Engineering, they are keenly interested in all of the activities of the general student body and the enterprises common to student life.

ENGINEERING SOCIETIES.

Branches of two national engineering societies, The American Institute of Electrical Engineers and the American Society of Mechanical Engineers have been established for several years. In each of these, meetings are held bimonthly for the discussion of current engineering problems, usually drawn from the publications of the national societies received regularly by the members of the

Engineers Parade.

branches. Practically all of the upper classmen in Electrical Engineering and Mechanical Engineering are active members of one or the other of the branches and a great deal of interest is taken in the meetings. These societies are strongly encouraged because of the benefits to be derived from practice in preparing and delivering papers before a critical audience and for the acquaintance with the activities of the prominent engineers composing the national societies.

ATHLETICS.

Students in all divisions of the University are encouraged to take part in Athletics in one form or another. Class teams and Varsity teams are maintained in football, baseball, basketball, tennis, track work, etc. These are all very carefully surpervised and under the direction of experienced coaches and trainers.

Rothwell Gymnasium is a stone building only a few years old. The gymnasium room is well lighted and well ventilated and equipped with the usual apparatus. Bathing, locker, and dressing facilities are provided in the basement. During good weather much of the systematic work is carried on in an outdoor gymnasium arranged near Rothwell Gymnasium.

"Rollins Athletic Field," named in recognition of the generosity of members of the Rollins family, is just west of Rothwell Gymnasium. It contains a quarter mile cinder track, a two hundred and twenty yard straight away, grounds for field athletics, a gridiron for football and a baseball field. All intercollegiate athletic contests are held here.

Concrete bleachers which seat 4,250 persons were constructed last summer. A new concrete fence with ornamental gate partially surrounds Rollins Field.

Tennis courts, basketball courts, baseball, football, and soccer fields for all students are situated near the gymnasium.

A nine-hole golf course is open to the faculty and all students.

EMPLOYMENT BUREAU.

The School of Engineering has always made an effort to secure employment for its graduates. No difficulty is ordinarily experienced in this respect; practically all of the senior class are generally engaged before Commencement Day. This year more opportunities have appeared than there are men to fill them.

Inquiries for men to fill advanced positions requiring more or less special experience are occasionally received. A file showing the records of graduates as they are received from time to time on blanks sent them for the purpose often makes it possible to recommend men particularly fitted for these positions.

Rebuilding a Planer in the Machine Shop.

This spring record blanks were sent to all of the graduates of the School of Engineering whose addresses were known, about 630 in all. At the time this is being written replies have been received form 209 of these. These records show that they are employed as follows:

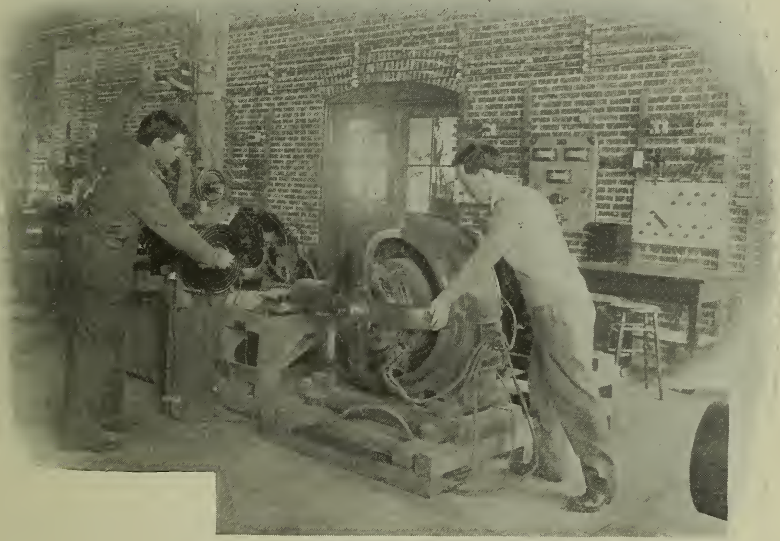
	Graduates in				
	Chemical Engineering	Civil Engineering	Electrical Engineering	Mechanical Engineering	Total
Banking		2	1		3
Street & Interurban Railways		1	4		5
Bridge Construction		6			6
Construction and Contracting		16	6	2	24
Consulting Work		3		1	4
Farming and Farm Products		3			3
Graduate Students		1			1
Heat, Light & Power		2	30	1	33
In Public Service					
United States	1	13	1	1	16
State		5	1		6
County		4			4
City		17	1		18
Lawyers		1			1
Manufacturing					
Railroad		1			1
Iron and Steel				4	4
Other Mechanical		1	3	4	8
Electrical			5		5
Miscellaneous	5		1	2	8
Medical and Health Work		2			2
Mercantile Work		1			1
Mining Engineering		3			3
Printing and Writing			1		1
Real Estate and Insurance				1	1
Steam Railroads		11		1	12
Teaching					
Colleges		6		3	9
High Schools					
Other Schools		1		4	5
Telephone and Telegraph		2	8		10
Apprenticeship Courses			8		8
Salesmen			4	2	6
Photographer		1			1
	6	102	75	26	209

FEES AND EXPENSES.

Tuition. Tuition is free in all divisions of the University to students who are residents of the State of Missouri. Non-residents of the State are required to pay a tuition fee of ten dollars ($10) a semester in all divisions of the University, except in the Graduate School.

Library, Hospital and Incidental Fee. All students in the University except those enrolled in the Summer Session and in the Short Winter Courses in Agriculture, and except those specially exempt by law or by rule of the Curators,* are required to pay a library, hospital and incidental fee of ten dollars ($10) a semester.

Laboratory Deposits: Each student entering a laboratory is required to make a deposit of $5.00, unless a different amount be fixed by the President and the Director of the laboratory. From the amount deposited there is deducted a fixed charge (in no case less than $1, for each individual laboratory course), and also all charges



Electrical Engineering Laboratory.

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*See the annual catalogue.

for materials used or for damages to or loss of University property. If the deposit is insufficient to cover all such charges the student is required to make an additional deposit or deposits. When damage or loss is suffered by a laboratory, it is assessed against the deposits of students using the laboratory at time of the damage or loss, unless such damage or loss can be traced to some individual student or students. The remainder of any deposit, after payment of all charges, is refunded to the student at the end of his laboratory course in any session, provided it be called for within twenty days after the close of the session. If not so called for, the amount will be credited to the laboratory in which deposit was made.

All fees and deposits must be paid in advance.

Books and Instruments. The cost of books varies considerably depending upon the courses being taken each year; a fair average is from $20 to $30 a year. A good set of drawing instruments is required in the first year's work in mechanical drawing and is used throughout the course. This should cost from $10 to $20 depending upon the quality.

Room Rent and Board. Rooms may be rented in Benton and Lathrop Halls, the University dormitories for men, at from $20.00 to $35.00 for each student for a session of 38 weeks. Two students occupy each room and the rent depends upon the location of the room.

For rooms in private houses from $8 to $16 a month is charged, the average being about $12. This is usually shared by two students.

In the University Dining Club, good table board is provided at a total cost of about $2.50 a week. During the past year a cafeteria has been in operation on the ground floor of Lathrop Hall in which the meals are served at an average weekly cost of from $3 to $4.

Board in private boarding houses usually costs from $3.50 to $5 a week. Private boarding clubs are formed in which the average cost is about $3 a week.

Total Expenses. The table below is intended to give an idea as to the probable yearly expenses of a student in the School of Engineering.

	Low Estimate	Medium Estimate	Very Liberal Estimate
Library, Hospital and Incidental Fee*	$20.00	$20.00	$20.00
Room Rent	23.00	50.00	90.00
Board	95.00	133.00	190.00
Laboratory Deposits	15.00	20.00	30.00
Books	15.00	25.00	35.00
Laundry	18.00	35.00	50.00
Society dues and assessments	2.00	10.00	25.00
Incidentals, amusements, etc	22.00	47.00	100.00
	$210.00	$340.00	$540.00

*Under certain conditions students are exempt from the Library, Hospital and Incidental Fee. For particulars, see the annual catalog.

Clothing and railroad fares are not included in this table. The actual expenditures will depend largely upon the tastes and inclinations of the individual student. The low estimate in the table is considered to be about the minimum amount required consistent with comfortable quarters and good food. It implies rigid economy in all things. The medium estimate is thought to be about the average amount spent by students in the School of Engineering.

There are many opportunities for a student to earn money to pay part or all of his expenses at Columbia. The Y. M. C. A. conducts an employment bureau to aid students in finding work of this kind. Students who must spend part of their time in outside employment should not expect to take full work in the University and under these circumstances an additional year is often required to satisfy the requirements for graduation. Students coming to Columbia for the first time should not expect to find work at once, but must have some funds available to meet necessary expenses until employment is obtained. This may require several months.

INFORMATION ABOUT THE UNIVERSITY

GENERAL STATEMENT.

The fundamental aim of the University of Missouri is the development of the highest and most efficient type of citizen. For the purpose of attaining its aim, the University furnishes ample facilities for liberal education and for thorough professional training. The University is a part of the public educational system of the State.

In the course of seventy-four years of development, new divisions of instruction have been organized in response to the needs of vocations followed by citizens of the State.

ORGANIZATION.

The work of the University is now carried on in the following Schools and Colleges:

College of Arts and Science
College of Agriculture
School of Education
School of Law
School of Journalism
School of Medicine
School of Engineering
School of Mines and Metallurgy
Graduate School
Extension Division

All of these divisions are at Columbia with the exception of the School of Mines and Metallurgy, which is located at Rolla. In addition, emphasis is given particular lines of work by the establishment of minor divisions, the chief of which are the Agricultural Experiment Station, the Engineering Experiment Station, and the Military School.

LOCATION.

The University of Missouri is located at Columbia, a town situated half way between St. Louis and Kansas City near the center of the state. It is reached by the Wabash and the Missouri, Kansas and Texas Railways. Columbia is a progressive and prosperous town having doubled its population in the last few years. It has nearly twenty miles of paved streets.

Columbia may be characterized as a town of schools, homes and churches, with enough of industrialism to make it efficient. It offers the conveniences of a larger city without the counter attractions. The student is a predominant factor in Columbia. He is one to three in numbers. The population of the town is 10,000.

EQUIPMENT.

The University grounds cover more than eight hundred acres. The main divisions are in the Quadrangle, the Horticultural Grounds, the Physical Education Grounds, and the Agricultural College Farm.

The following University buildings are located at Columbia: Academic Hall; Laws Observatory; separate buildings for Chemistry, Agricultural Chemistry, Physics, Zoology and Geology, Law, Engineering, Manual Arts, three power houses; Medical Laboratory Building; Parker Memorial Hospital including the Busch Clinic; Agricultural Building; Horticultural Building; Green Houses; Live Stock Judging, Dairy, Farm Machinery, and Veterinary Buildings, and the Agricultural College Farm Barns and Buildings; Switzler Hall, for the School of Journalism; Benton and Lathrop Halls, dormitories for men; Read Hall, the dormitory for women; Rothwell Gymnasium; the houses for the President of the University and the Dean of the College of Agriculture; the High School, and the Elementary School Buildings used for practice schools in the School of Education.

FOR FURTHER INFORMATION.

Full information regarding the University is given in the catalogue which will be sent on request without charge. For this or special bulletins of the Graduate School, College of Arts and Science, College of Agriculture, School of Education, School of Law, School of Medicine, School of Engineering, School of Journalism, and Extension Division, write to

DEAN OF THE UNIVERSITY FACULTY,
University of Missouri,
Columbia, Missouri.

UNIVERSITY CALENDAR

AT COLUMBIA.

Summer Session

1913		
June 12	Thursday, Registration.	
June 13	Friday, Organization of Classes.	
July 4	Friday, Holiday.	
August 12	Tuesday, Lectures Close.	
August 13	Wednesday	Examinations.
August 14	Thursday	

First Semester

September 15, 16, 17	Monday, Tuesday and Wednesday, Entrance Examinations and Registration.	
September 18	Thursday, at 8 a. m., Class Work in All Divisions Begins.	
September 18	Thursday, at 10 a. m., Opening Convocation.	
October 2	Thursday, Quarterly Meeting of Curators.	
November 27	Thursday, Thanksgiving Holiday.	
December 16	Tuesday, Annual Meeting of Curators.	
December 19	Friday, at 4 p. m. to	Christmas Holidays.
1914		
January 5	Monday, at 8 a. m.	
January 24	Saturday to	Mid-Year Examinations.
January 31	Saturday	

Second Semester

January 29, 30, 31	Thursday, Friday and Saturday, Entrance Examinations.	
February 2, 3	Monday and Tuesday, Registration, Second Semester.	
February 4	Wednesday, at 8 a. m., Class Work in All Divisions Begins.	
February 5	Thursday, at 10 a. m., Opening Convocation.	
April 2	Thursday, Quarterly Meetings of Curators.	
April 9	Thursday, at 4 p. m. to	Easter Holidays.
April 15	Wednesday, at 8 a. m.	
May 31	Sunday, Baccalaureate Address.	
June 1, 2	Monday and Tuesday, Senior Class Exercises.	
June 3	Wednesday, Alumni Day.	
June 4	Thursday, Commencement Day.	
June 4	Thursday, Semi-Annual Meeting of Curators.	
June 5	Friday, to	Final Examinations.
June 12	Friday	

THE
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BULLETIN

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FOR 1913 VOLUME 14

EDITED BY
HUGH J. MacKAY
University Publisher

Number 1, January	Summer Session
Number 2, February	College of Arts and Science
Number 3, March	Graduate School
Number 4, April	School of Education
Number 5, May	Catalogue
Number 6, June	School of Medicine
Number 7, July	School of Law
Number 8, August	School of Journalism
Number 9, September	School of Engineering
Number 10, October	College of Agriculture
Number 11, November	College of Agriculture (Short Courses)
Number 12, December	Second Semester Courses

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THE
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BULLETIN

VOLUME 15 NUMBER 15

GENERAL SERIES
1914, No. 6

ANNOUNCEMENT
OF THE
SCHOOL OF ENGINEERING
1914-1915

MAR 6 1917

UNIVERSITY OF MISSOURI
COLUMBIA, MISSOURI
May, 1914

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May, 1914

The Engineering Building.

THE MODERN ENGINEER

In 1828 the Institution of Civil Engineers was organized in London. In the charter of the Institution, civil engineering was defined as the "art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states, both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation and docks for internal intercourse and exchange, and in the construction of harbors, moles, breakwaters and light houses, and in the art of navigation by artificial power for the purpose of commerce, and in the construction and adoption of machinery, and in the drainage of cities and towns."

For many years this definition has been a classic, regarded as expressing a definite view of the field covered by engineering practice. Many changes have occurred since the organization of the great Institution, and the enumeration of lines of work might be considerably modified and extended if it were to be written at the present time. To prepare a complete statement of what constitutes the entire field of engineering would be a large task, and it is only proposed here to give some brief account of the various fields of activity in which engineers may be engaged, and of the demands of practice upon the modern engineer.

HISTORICAL SKETCH

Previous to the middle of the eighteenth century, engineering was applied almost exclusively to the purposes of war. In a few instances public works intended for other purposes were constructed, but usually the engineers were military officers and the works executed by soldiers. About this period, however, a new class of engineers appeared, who concerned themselves with works of much the same character, but not military in purpose and not executed by soldiers. These men were known as "civil engineers" to distinguish them from the "military engineers." The increase in urban population and development of trade made a demand for public works, and for machinery, which soon caused the importance of the new profession to be recognized, and the number of its members to rapidly increase.

During this early period there was no division of the field of engineering into specialties. Civil engineers covered the whole range of works included in the definition. Among these early engineers were a number of very able men, who with but little training in the laws of science, and without precedents of practice to guide them, succeeded in accomplishing difficult engineering feats, and in establishing a safe and rational practice.

About the middle of the nineteenth century the industrial development which followed the invention of the steam engine had so widened the field of engineering practice, and so increased the demands upon the engineering profession, that a single engineer could no longer cover the whole range of practice, and engineers began to devote their attention to more restricted lines of work. This resulted in dividing engineers into classes, each devoting its attention to a special field.

DIVISION INTO SPECIALTIES

The demand for motor power and machinery for industrial enterprises and transportation caused many engineers to devote themselves exclusively to such work. These men were called "mechanical engineers" and soon were recognized as a distinct branch of the profession. The term civil engineer was still applied to those not primarily concerned with the production or operation of machinery.

Almost immediately following the establishment of mechanical engineers into an independent profession, mining engineering became in the same way a separate branch. The demand for metals and coal consequent upon the industrial development already mentioned caused many engineers to devote their whole attention to the opening and operation of mines. These were called "mining engineers."

Near the close of the nineteenth century the discovery of methods of applying electricity to numerous uses and the consequent immense development of electrical plants and appliances caused many men to devote their attention primarily to electrical work. These men were recognized as a distinct branch of the profession and called "electrical engineers."

Recently the development of chemical industries has created a demand for men who give their attention primarily to the construction and operation of plants for manufactures in which chemical processes play a leading part. These men are called "chemical engineers."

At present these five divisions of engineering practice are commonly recognized as distinct professions, or as distinct branches of the engineering profession. Schools of engineering commonly give separate curricula leading to degrees in each of these divisions, and while much of the training necessary to make an engineer is common to several or all of them, each engineer is usually recognized as belonging in one division, and limits his practice to his special branch.

The field of engineering practice is constantly widening. Great changes have taken place during the last few years in the standards of living of the people; urban populations have grown rapidly; manufacturing industries have greatly increased in number and become more diversified. The result of all this has been to make larger demands for the services of the engineer and to enlarge the scope of his activities. This growth has naturally caused a further sub-division of the various branches of engineering practice into narrower specialties, not usually recognized as separate professions, but each offering a sufficient opportunity for the exercise of the best endeavors of the men who follow them.

CIVIL ENGINEERING

The term civil engineering is still often used in its original sense as covering all engineering not military, but commonly it is limited to those fields of practice not included in the other branches.

In the number of special fields of work included, it is much the broadest branch of engineering practice. It comprises:

Stream Measurement.

Surveying, which in simple forms is used by all civil engineers, but which when applied in geodetic and topographic work may constitute a distinct field of practice.

Hydraulic engineering, which includes the design and construction of harbors and docks; river improvements, canals, irrigation works, drainage and flood prevention, and water power projects.

Sanitary engineering, covering all works designed to protect the public health, such as water supply and water purification, sewerage and sewage disposal, and the disposal of garbage and refuse.

Highway engineering, in which may be included both the maintenance and improvement of country roads and the construction and maintenance of city streets and pavements.

Railway engineering, which deals with the design, construction and maintenance of all the works required for steam and electric railways.

Structural engineering, which is concerned with the design and construction of bridges and of the structural features of large buildings that carry heavy loads, masonry and concrete structures, and heavy foundations.

General construction, under which head may be included the execution of large works of construction, and the transportation and handling of heavy materials.

MECHANICAL ENGINEERING

The term mechanical engineering is usually employed to designate the work of those engineers who have to do primarily with steam or other engines, machine tools, mill work and moving machinery in general. The lines of work included in the practice of a mechanical engineer may be:

Power engineering, which consists in the design, construction, and operation of machines and plants for the generation of power. These may include steam, gas, oil, or other engines, with all the auxiliary appliances necessary to their operation, as well as the various methods of power distribution.

Design of plants and machinery for the utilization of power, requiring the study of special processes for which machinery may be required, and the adaptation of machines and arrangement of plants for purposes of economical production.

Shop management, dealing with the control and management of shops in the operation of manufacturing plants.

Gas engineering, covering the production, distribution, and utilization of gas for light, heat, and power purposes.

Railway mechanical engineering, consisting of the design, construction, and operation of rolling stock and other machinery, and of the shops required in the operation of railways.

ELECTRICAL ENGINEERING

Engineers who are concerned mainly with the generation, transmission, or utilization of electrical energy are known as electrical engineers.

The last few years have seen a very great increase in the applications of electricity and the field of its usefulness is constantly widening. The special fields of most importance into which electrical engineering is divided are:

The design, construction and operation of telephone and telegraph systems.

The design and construction of generators, motors and other apparatus required in the generation, distribution and utilization of electric power.

The design, construction and operation of plants for generating electric power and lines for its transmission.

The application of electricity to industrial power.

The building and operation of electric railways.

The utilization of electric energy for lighting purposes.

The application of electricity in the various chemical industries.

CHEMICAL ENGINEERING

Engineers with special training in chemistry, who devote themselves to the development of the various chemical industries, are known as chemical engineers. Much of recent progress is due to the discovery and development of new materials and compounds with characteristics that make them valuable in the arts. A great part of the research being carried on for commercial purposes lies along these lines. A man who has had a thorough training in chemistry, and who combines with his knowledge of chemistry an insight into physical and mechanical problems and an appreciation of the commercial significance of his work, is best qualified to make himself valuable in investigation of this kind. Not only the discovery of new products, but the maintenance of a standard of quality in manufactured materials, demands the labor of men who have a knowledge of chemistry.

This field of work is rapidly becoming very large because of the many and varied industries which have been and are being developed.

RELATION OF ENGINEERS TO SOCIETY

Attention has already been called to the great changes which have taken place in the status of the engineering profession in consequence of the development of industries and the altered standards of living during the past century. These improved social conditions are, for the most part, the result of the work of the engineer. The discoveries of modern science as applied in engineering practice have worked miracles for the better health, comfort, and convenience of modern life.

The invention and perfection of the steam engine was followed by the development of the factory system, making possible the supply of all kinds of manufactured articles at low cost. Then came the steamboat and railroads as methods of transportation, gas for illumination, and the telegraph for quick communication, and later all the various electric appliances, and in our cities water supply, paving, and sewage disposal. These things have changed the whole aspect of life, both in city and country, and have made the engineer absolutely essential to modern progress.

In view of the enormously important part which the engineer plays in the life of today, it is very necessary that he should be well trained and fully prepared to meet the responsibilities which rest upon him. In a state possessing immense natural resources, capable of development to a position of great wealth and power, and of providing occupation and homes for a large population, it is highly important that there be found a body of engineers able to direct this development in the best way, that resources may be conserved, and improvements economically made. It is also important that the youth of the state have opportunity to make the best of themselves in whatever field of endeavor may be most attractive to them. It is therefore the duty of the School of Engineering to provide a thorough and adequate training for the young men who seek to be engineers, and to maintain a high standard of admission to the profession.

OPPORTUNITIES FOR ENGINEERS

There are good opportunities in engineering practice for able and well trained men. Success in engineering depends upon hard application and experience. It is a strenuous occupation and holds forth no inducements to the man who is looking for an easy way to make a living. During the last few years usually there have been more openings for graduates then men to fill them. Entrance into engineering work has been easy for the man who has shown energy and ability as a student. After entrance into practice, the future of the engineer depends upon himself. There is opportunity of advancement for the man whose training has developed capacity for work, and who has interest in his work. The financial rewards are not great usually, although the more successful men have little cause for complaint. The true engineer has enthusiasm for his work. Opportunity for service is more to him than personal gain.

The largest field for engineering practice is in the service of various corporations. A few engineers, after obtaining considerable experience, are able to practice as independent consulting engineers, or as designing engineers for special lines of work. Many leave the technical side of engineering work and take up administrative positions, or become connected with the business side of industrial enterprises. Remuneration is commonly greater in such work than in the purely technical work of engineering design.

The rapid growth of public interest in the affairs of corporations controlling public utilities emphasizes a field of work which is peculiarly suitable for engineers. In this and many other states, public service commissions have been established having much power in the regulation of the business of public service corporations. For example, they may fix rates and enforce standards of quality, quantity and service; they may authorize bond issues or forbid them, depending upon the financial condition of the corporation. In the exercise of these and other functions, the commissions need the services of well trained engineers as do also the corporations affected by the commissions. To be fitted for work of this nature, the engineer must not only be well equipped with technical knowledge but must also thoroughly understand and appreciate the legal, economic, commercial, social, and ethical questions involved in problems of valuation, rate fixing.

Another field of activity for engineers is suggested in the increasing tendency of municipalities to own and operate their electric light and power, water and gas plants. Heretofore the work of the municipal engineer has been largely confined to planning and overseeing the construction and maintenance of streets and pavements, sewers, parks, water mains. The training necessary to qualify for work of this kind has been best supplied by the curricula in civil engineering. For municipalities owning and operating their public utilities the office of city engineer may be well filled by a mechanical or electrical engineer who has included in his technical training, the proper courses covering surveying, streets, pavements, sanitation, sewers, water supply. A student following the regular civil engineering curriculum may prepare for the same field of usefulness by completing courses concerning the principles of steam and electrical machinery and power plants, pumping machinery, lighting and water systems.

Rebuilding a Planer in the Machine Shop.

THE TRAINING OF ENGINEERS

The education and training of most of the best modern engineers is accomplished by a course of study in a technical school, followed by experience in actual practice. Both are necessary to produce the well equipped engineer. The technical school gives a training in the sciences, and to some extent in the arts which underlie engineering practice. The object should be to develop power in the student to deal with problems involving mathematical and physical sciences, and to cultivate the faculty of independent thought in dealing with such problems.

The fields covered by civil, electrical, mechanical and chemical engineering are so broad and so varied in character that at first it may not be apparent that they possess points in common which cause them to be grouped under a single classification and called engineering. Some of the considerations which are involved in work that is distinctively engineering in character are:

The work must be essentially useful, and those bearing the responsibility must be convinced of its success and utility before it is undertaken.

It has to deal, at some point, with the forces of nature so that the problems involved demand a knowledge of natural laws for their solution. But while some physical, chemical or mechanical problem is always present it is very often necessary to deal with psychological, economic or social factors as well.

Commercial or economic considerations are the determining factors in nearly every engineering problem.

These are some of the features in the problems themselves that make them essentially engineering problems. Engineering has also its characteristic methods, and while these methods may be used by others the engineer is especially at home with them. They involve:

The collection, classification and analysis of data bearing on the problem in hand.

The use of graphical representations of physical laws and characteristics.

The application of known physical laws to the design of apparatus and to the prediction of the action of the thing designed.

Conservatism to insure the building of things for safety and reliability.

The basing of decisions on sound financial policy and ultimate long term economy.

The review of the result and the tempering of the decision in the light of judgment and experience.

These methods of handling problems are sufficiently well defined and systematic to make experience and training along one line valuable in almost any other kind of work. The man who has had good engineering training is exceptionally well fitted to meet and solve problems in any sphere of activity.

The demands of modern engineering practice are for men of broad training. The man who is trained only in the technical side, however thorough may be his acquaintance with the sciences and however skillful he may be in working out the technical features of a design, can not achieve the highest success in his profession. Executive and administrative positions carrying the most responsibility and earning the highest remuneration are frequently best filled by men having engineering training. The duties pertaining to positions of this character are usually more concerned with the commercial rather than the purely technical side of engineering and the qualities which go farthest toward making success are business sense and the ability to deal with people. These qualities are most likely to occur in men whose viewpoint is broad and who can understand and sympathize with the motives and interests of others.

The idea is too prevalent among young men preparing themselves for the practice of engineering that nothing is of importance in such preparation which does not directly concern the technical features of their work and they are even inclined at times to look with disdain upon work in other branches of engineering than their own.

This tendency is usually more marked among those in the earlier stages of preparation than later, when the student has reached a point where he begins to realize something of the real character of the work upon which he is about to enter. It is, therefore, important that those entering upon a course of training in preparation for professional work should be made to realize that breadth of training is necessary. The man who devotes himself exclusively to the technical work of his profession, may become highly skilled in such work. He may be a valuable man in the work with which he is familiar and highly appreciated for his technical skill by the broader man who is chief over him, but he will not be a chief himself. Men develop capacity for directing large affairs by acquiring intimate knowledge of their fellow men and learning how to deal with them. The training and experience of an engineer should give him capacity to direct large business projects, requiring judgment in matters pertaining to engineering. They should make him the logical man to control such enterprises. In order to be fitted for this work, a man must not only be expert in the technical details of the work, but he must have such knowledge of history and such an acquaintance with social and economic laws as to enable him to appreciate the relations of his work to the world about him.

He must, moreover, be able to formulate his ideas concisely and intelligibly, and to present them to others in an agreeable and convincing manner.

These matters should be seriously considered by the young man about to embark on a course of training which is to fit him for the practice of engineering, as well as by those having the direction of students looking forward to such practice. The leading technical schools are at present showing a tendency toward the requirement of broader training as preparation for admission into the engineering curricula, and the School of Engineering of the University of Missouri now requires that two years of work in the College of Arts and Science of this University, or in some other institution of the same character, shall precede admission into the School of Engineering. The technical work in the School of Engineering, then, occupies three years, making a total requirement of five years of college and university work. It is also recommended that, for students able to spend a longer time in preparation, the curriculum for a degree in Arts be completed. With proper arrangements of the college work, it is possible to cover the work for both degrees in six years.

PRELIMINARY COLLEGE TRAINING

When the questions discussed in the preceding paragraphs are seriously considered, the reasons for requiring two or more years of college work before permitting a student to enter the School of Engineering for his technical training become apparent. Briefly stated, these reasons are:

1. Thorough preparation in the sciences which necessarily precede the technical courses of the engineering curricula. For this purpose the college work should comprise mathematics, including trigonometry, algebra, analytical geometry and calculus, a course in general chemistry and a course in general physics. These courses are among the requirements for admission to our engineering school and their lack is a serious handicap to those entering without full credit in them. It is also desirable to have had some courses in shop work before entrance; this work preferably being done in the high school.

2. The necessity of widening the intellectual horizon by education along general lines looking toward a future as a broadly trained professional man. To this end the student should include as much general training as possible in this preliminary work. He should study at least one modern European language, and have some work in history and economics, while most of the courses commonly offered dealing with literature and social science will be of value to broaden the outlook upon life, and fit the student for his position as a member of society.

3. The acquiring of a certain maturity of mind necessary to receive the greatest value from the later technical studies.

4. A greater opportunity for training in the use of good English. Every student should make a determined effort to obtain a good command of the English language, to speak and write correctly, and to express himself with ease and clearness. This is a matter of the highest importance in any profession; and to an engineer who desires to rise above the routine work of a minor position, there can be no greater handicap than inability to use English readily and correctly.

TECHNICAL TRAINING

After the student enters the School of Engineering, his attention must necessarily be given mainly to the technical courses required for his professional training. These courses include instruction in the principles of the sciences which underlie engineering practice, and in the applications of these sciences to engineering problems, as well as in the methods employed by engineers in actual practice.

Several methods of instruction are employed depending in each instance upon the character of the work and the purpose with which it is given. Lectures, recitations, and quizzes are used for the purpose of giving a connected development of methods of practice in a given field. Problems in computation and design are employed to show the ways in which scientific principles are applied to engineering problems, to illustrate methods used in practice, and to develop the ability of the student to apply his scientific knowledge to questions arising in engineering design. Laboratory instruction is freely used to illustrate principles outlined in lecture courses, to familiarize the student with the construction and operation of machines or with the behavior of materials, and to develop capacity for independent investigation.

Efficient preparation for practice in any of the branches of engineering requires a broad training in the fundamental applications of science which underlie such practice, as well as some knowledge of the principles and methods of practice in the other fields of engineering. Narrow specialization is never allowable in undergraduate work. Engineering curricula, therefore, are made up mainly of required courses necessary to this fundamental training, but a certain amount of time is usually available for elective work in which a student may study more fully in one of the special lines of practice, or in which he may obtain a wider knowledge of fields of practice outside his own. The way in which elective time may be utilized to the best advantage varies with the preparation of the student and the purpose he has in view. The object should always be to secure symmetrical training, carrying preparation for the special field of practice as far as may be possible without sacrificing breadth of foundation.

THE SCHOOL OF ENGINEERING

Instruction in engineering at the University of Missouri began in 1877, when a Chair of Civil Engineering was established in the College of Agriculture and Mechanic Arts, with a curriculum leading to the degree of Civil Engineer. Later, as the demand grew for technically trained men in the more restricted branches, instruction was offered in mechanical and in electrical engineering. In 1907, the engineering departments were separated from the College of Agriculture, and organized as an independent division of the University, known as the School of Engineering. This school now offers four curricula leading to degrees:

Civil Engineering.
Electrical Engineering.
Mechanical Engineering.
Chemical Engineering.

The object of the several curricula is to provide a broad, thorough and systematic training in the fundamental applications of the sciences which underlie the work of the engineering profession in its different branches, together with some opportunity for specialization by the proper selection of elective courses.

OFFICERS OF INSTRUCTION AND ADMINISTRATION

ALBERT ROSS HILL, A. B., Ph. D., LL. D.,
President of the University.

ELMER JAMES McCAUSTLAND, C. E., M. C. E.,
Dean of the Faculty of Engineering and Director of the Engineering Experiment Station.

EDWARD BAYER BRANSON, A. B., A. M., Ph. D.,
Professor of Geology.

WILLIAM GEORGE BROWN, B. S., Ph. D.,
Professor of Technical Chemistry.

*SIDNEY CALVERT, B. S., A. M.,
Professor of Organic Chemistry.

LUTHER MARION DEFOE, A. B.,
Professor of Mechanics in Engineering.

EARL RAYMOND HEDRICK, A. B., A. M., Ph. D.,
Professor of Mathematics.

HERBERT WADE HIBBARD, A. B., A. M., M. E.,
Professor of Mechanical Engineering.

OLIVER DIMON KELLOGG, A. B., A. M., Ph. D.,
Professor of Mathematics.

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*On leave of absence, session 1913-14.

HERMAN SCHLUNDT, B. S., M. S., Ph. D.,
Professor of Physical Chemistry.
FREDERICK PUTNAM SPALDING, C. E.,
Professor of Civil Engineering.
OSCAR MILTON STEWART, Ph. B., Ph. D.,
Professor of Physics.
LEWIS DARWIN AMES, A. B., A. M., Ph. D.,
Associate Professor of Mathematics.
ROBERT HORACE BAKER, A. B., A. M., Ph. D.,
Associate Professor of Astronomy.
EDWIN ALLAN FESSENDEN, B. S. in M. E., M. E.,
Associate Professor of Mechanical Engineering, in charge of the Office of the Dean, Session 1913-14.
IRA SAMUEL GRIFFITH, A. B.,
Associate Professor of Manual Arts.
ABRAHAM LINCOLN HYDE, Ph. B.,
Associate Professor of Bridge Engineering.
WILLIAM ALVAN MILLER, B. S. in C. E.
Associate Professor of Railway Engineering.
THOMAS JACOB RODHOUSE, B. S. in C. E., M. C. E.,
Associate Professor of Hydraulic Engineering and Mechanical Drawing.
WALTER SCOTT WILLIAMS, C. E.,
Associate Professor of Topographic Engineering.
JAMES ANDREW GIBSON, A. B., M. A.,
Assistant Professor of Analytical Chemistry.
HARVEY CLAYTON RENTSCHLER, A. B., A. M., Ph. D.,
Assistant Professor of Physics.
WILLIAM ARTHUR TARR, B. S., B. S. in M. E.,
Assistant Professor of Geology and Minerology.
MENDEL PENCO WEINBACH, A. B., B. S. in E. E., A. M.,
Assistant Professor of Electrical Engineering.
*ARTHUR LORD WESTCOTT, B. M. E., M. E.,
Assistant Professor of Mechanical Engineering.
WILHELMUS DAVID ALLEN WESTFALL, A. B., Ph. D.,
Assistant Professor of Mathematics.
KERR ATKINSON, M. E.,
Instructor in Electrical Engineering.
JOHN HARLAND BILLINGS, B. A. Sc.,
Instructor in Mechanical Engineering.
PERCY WILCOX GUMAER, A. B., B. S. in E. E.,
Instructor in Electrical Engineering.

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*On leave of absence, session 1913-14.

WEBSTER NEWTON JONES, A. B., A. M.,
Instructor in Organic Chemistry.
EDWARD WASHBURN KELLOGG, C. E.,
Instructor in Electrical Engineering.
HARRY ANDERSON LA RUE, B. S. in C. E., C. E.,
Instructor in Civil Engineering.
GUY DORIC NEWTON, B. S. in M. E.,
Instructor in Mechanical Drawing and Descriptive Geometry.
GEORGE REEDER,
Lecturer on Meteorology and Climatology.
*AUSTIN HUBBARD WELCH, B. S. in M. E., M. E.,
Instructor in Mechanical Drawing.
JAMES ROY WHARTON, B. S. in M. E., M. E.,
Instructor in Mechanical Engineering.
MARSHAL HENRY BRIGHAM,
Assistant in Manual Arts.
JILES WILLIAM HANEY, B. S. in M. E.,
Research Assistant, Engineering Experiment Station.
GARRETT ANTHONY MUILENBURG, A. B., M. S.,
Research Assistant, Engineering Experiment Station.
LEO MURRAY NEUMAN, B. S. in C. E.,
Research Assistant, Engineering Experiment Station.
ISADOR SARINSKY, B. S. in C. E.,
Research Assistant, Engineering Experiment Station.
CAROL EDWIN ABBOTT,
Student Assistant in Manual Arts.
FRANK HENRY FRAUENS, JR.,
Student Assistant in Mechanical Engineering.
FRANK AUGUST HEILEMAN,
Student Assistant in Mechanical Engineering.
CARTHRAE MERRETTE LAFFOON,
Problem Reader in Mechanics.
MORRIS MARKS,
Problem Reader in Mechanics.
RUSSELL GRIFFITH THOMPSON,
Problem Reader in Mechanics.

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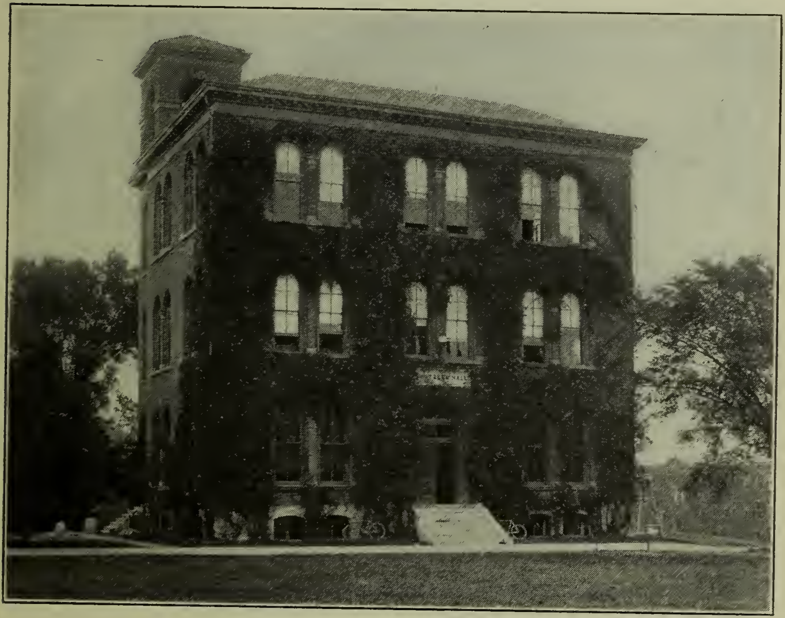
*On leave of absence, session 1913-14.

BUILDINGS AND EQUIPMENT

The departments of electrical and mechanical engineering occupy the main Engineering Building and the department of civil engineering half of Switzler Hall. The work in chemistry required of students in chemical engineering is given in the Chemistry Building.

The main engineering laboratories are in the Engineering Annex in the rear of the Engineering Building. A substantial addition to the Engineering Annex has been completed during the last year which is is to be used for the expansion of the mechanical engineering laboratory and for the development of a hydraulic laboratory. Shop work is conducted in a building recently erected for the purpose.

Civil Engineering. The laboratory for testing materials is in charge of the department of civil engineering. The equipment includes several vertical testing machines with all the necessary accessories for tension, compression and transverse tests on the ordinary engineering materials, iron, steel, cement, concrete, brick; a beam testing machine; a torsion machine; impact and abrasion machines. There is also a complete equipment for all the standard tests upon hydraulic cement.



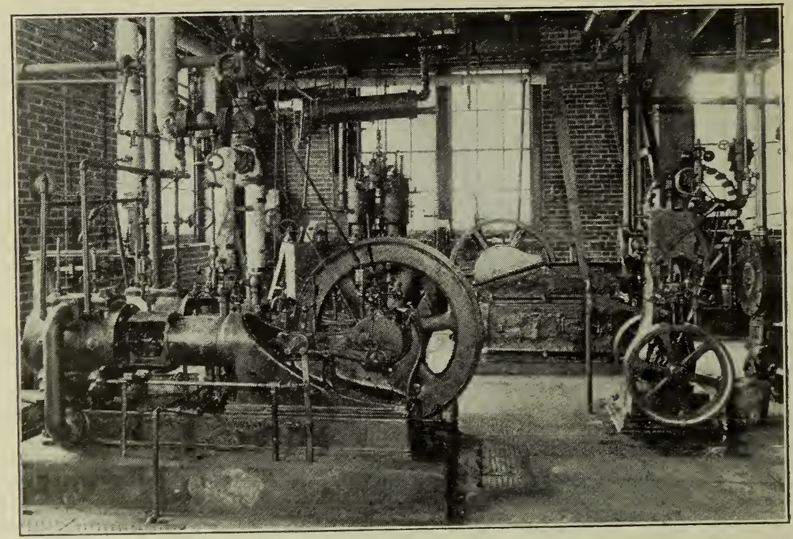
Switzler Hall.

The road materials laboratory contains the necessary machines for making complete tests upon stone for road purposes, a standard rattler for paving brick tests, and the apparatus required in investigating bituminous road materials.

There is a good collection of surveying instruments, including the instruments used in ordinary field practice and those necessary for precise surveying and geodetic work.

Stream gauges, with a dam and weirs on streams near Columbia, afford opportunity for field study of water supply problems, while practice in hydrographic surveying and stream measurement is obtained by a trip to a river in the neighborhood.

Mechanical Engineering. The mechanical engineering laboratory contains several different types of steam engines, a small steam turbine with a superheater, condensers, gas engines, reciprocating and centrifugal pumps, a number of fans, blowers, and heating coils for work on ventilation and heating, and a variety of other machinery. Much attention is paid to the study of fuels of all kinds and complete standard apparatus for determining the analysis and calorific value of coals and gases is provided. The laboratory is supplied with the usual equipment of indicators, guages, water and gas meters, scales, and other necessary accessories.



A Corner in the Mechanical Engineering Laboratory.

The central power plant of the University is used for conducting boiler tests under actual operating conditions. Considerable attention is given to the study of refrigeration. Several small ice and cold storage plants belonging to the University are available for tests. A local privately owned plant is also sometimes used.

Part of Electrical Engineering Laboratory.

A high grade lathe, completely equipped for use in connection with courses in shop efficiency, has been purchased recently. It will be used to make production tests to determine the proper kinds of tools and the best cutting speeds to use in making machine parts.

Electrical Engineering. The electrical engineering laboratory contains direct and alternating current generators and motors of the common types met with in practice, and all the instruments necessary to make complete tests of their operation. Besides several low ratio transformers used in routine exercises, the laboratory has a 10,000 volt transformer for testing dielectric strengths and one of 40,000 volts for high tension experiments. A set of Edison cells and one of chloride cells are available for experiments on storage batteries.

A low voltage motor-generator is set provided for general electro-chemical processes, such as electro-plating with gold, silver, nickel, and copper. One large and several small electric furnaces are used for demonstrations of the electric processes involved in the production of carborumdum, graphite, emery, calcium carbide, ferro-alloys.

The telephone equipment comprises a demonstration board showing all the apparatus and operations involved in a connection through two offices. For experiments in telephone transmission there is a high frequency generator and an artificial line which is electrically equivalent to fifty miles of underground wire.

The laboratory also has a quadruplex telegraph set.

Chemical Engineering. In addition to the laboratories in general chemistry, there are separate laboratories for the other fundamental courses in chemistry required in the chemical engineering curriculum. The general analytical laboratory offers facilities for work in qualitative and quantitative analysis. Special work in the technical analysis of fuels, water, gas, and commercial products is to be given in smaller laboratories equipped especially for these lines of work. Two laboratories are available for general work in organic chemistry, and more advanced work along organic lines is provided for in a furnace room and a laboratory for the preparation of organic compounds. The laboratory in physical chemistry is equipped for work in electro-chemistry and measurements in radio-activity. Advanced students have an opportunity to pursue work in metallography. The electrical laboratories in the Engineering Building offer facilities for work in electroplating, storage battery engineering, and electrical processes.

Library. The engineering library in the Engineering Building has 4,500 standard engineering books. These have been very carefully selected and include the works of all of the best American and English engineering authors. About 100 periodicals are regularly received together with publications recording the transactions of the more important engineering societies.

Engineering students are permitted free access to the library shelves for reference and are encouraged to draw books for outside reading.

The general library of the University and the library of the State Historical Society together containing about 200,000 books and pamphlets are open to all students in the University.

Forge Shop.

ENGINEERING CURRICULA

ENTRANCE

The opinion is rapidly gaining ground that a liberal training in the fundamental sciences and in cultural subjects is essential to success in engineering. This University was the first of the state universities to recognize this to the extent of requiring two years of college work before entrance to the School of Engineering.

The requirements for admission to the School of Engineering are the satisfactory completion of (1) a four years' high school course or its equivalent, and (2) the first two years' work or 60 hours' credit in the College of Arts and Science of the University of Missouri or its equivalent. This credit must include inorganic chemistry, 5 hours; calculus, 8 hours; general physics, 10 hours; students who do not present these credits for entrance must take such courses in addition to the courses in the engineering curricula.

It is desirable that students shall also have completed the elementary work in shop and drawing. Ten hours' credit in manual arts are accepted as part of the 60 hours' credit in the College of Arts and Science required for entrance.

Students entering the College of Arts and Science to prepare for entrance to the School of Engineering should so state when first enrolling in the University in order that their work may be arranged to include all of the specific subjects required for admission to the School of Engineering.

Students from other colleges or universities are admitted to the School of Engineering upon the same conditions as from the College of Arts and Science of this University provided the credits offered for entrance represent the equivalent of the training given by the College of Arts and Science. Much time can usually be saved in registration if these credits are determined in advance; address communications regarding entrance to the Dean of the University Faculty, University of Missouri, Columbia, Missouri.

Students may obtain both the A. B. and an engineering degree in six years. Those who can afford the additional year required are urged to take advantage of the opportunity thus afforded for general cultural training combined with an engineering education. This is made possible by—

(a) The acceptance of the following subjects (to a maximum of 20 credit hours) for the A. B. degree: Mechanics (courses 101, 103, 104, 109, and 120); direct current machinery (electrical engineering, 101a and 102b), 8 hours; elementary alternating currents (electrical engineering, 110a), 5 hours; heat engines (mechanical engineering, 135 a), 3 hours; descriptive geometry (mechanical drawing, 9a or 9b), 2 hours; elementary surveying (civil engineering, 101a or 102a), 2 or 3 hours; woodwork and forging (manual arts, 1a), 1 or 2 hours; patternmaking (manual arts, 2a), 2 hours; mechanical drawing (manual arts, 7a), 3 hours.

(b) The waiving of certain restrictions in the choice of electives in the School of Engineering, for students having an A. B. degree.

Students desiring to take both the A. B. and an engineering degree should plan their work carefully from the beginning to insure that the following items are accomplished in their first four years:

1. The completion of all the requirements of the A. B. degree (see the annual catalogue).

2. The satisfaction of all the requirements for entrance to the School of Engineering (see annual catalogue).

3. The completion of sufficient electives chosen from the subjects from the School of Engineering that are accepted toward an A. B. degree (see list in paragraph (a) above) to reduce the required engineering courses remaining to be taken in the last two years to a maximum of 60 credit hours.

Curricula meeting all these requirements are not difficult to arrange and considerable latitude may be allowed to satisfy individual needs and inclinations. To assist students in planning their work, a number of suggestive curricula are on file in the office of the dean, School of Engineering.

The courses in engineering require that students be strong in mathematics and science. Those who are not strong in these lines are advised not to undertake work in engineering.

For a full statement of the requirements for entrance to the College of Arts and Science, see the annual catalogue of the University. This may be secured by addressing the Dean of the University Faculty, University of Missouri, Columbia, Missouri. For special information not found in the catalogue, address the Dean of the School of Engineering, University of Missouri, Columbia, Missouri.

CURRICULA

There are four three-year curricula leading respectively to the degrees of Civil Engineer, Electrical Engineer, Mechanical Engineer, and Chemical Engineer. The completion of 90 credit hours as specified in the respective curricula is required for each of these degrees.

CIVIL ENGINEERING

The field covered by this curriculum is wide, embracing topographical, railway, hydraulic, structural, municipal, and highway engineering. It is the aim to give a broad general training which may later serve as a foundation for the development of any special line under the general term, civil engineering.

The curriculum has, therefore, been arranged with the purpose of providing thorough training in those fundamental sciences and principles upon which the practice of the civil engineer is based, and also, in so far as practicable, of giving instruction in the special subjects which underlie the several branches. A number of subjects are made elective, with the object of permitting the student to select his more advanced work in one of the special divisions of civil engineering.

A Class in Design.

The degree of Civil Engineer is conferred upon the completion of 90 credit hours including the following courses:

General Subject	No. of Course	Special Title	Hours Credit
Drawing	7a or 7b	Mechanical drawing	3
Drawing	9a or 9b	Descriptive geometry	2
Drawing	3a	Topographic drawing	1
Drawing	8a or 8b	Machine drawing	2
Mechanics	103	Mechanics of engineering	8
Geology	2a or 2b	Physical geology	3
Astronomy	3	Spher. and prac. astronomy	4
Mechanical engineering	131a	Engines and boilers	2
Mechanical engineering	124b	Mechanical laboratory	1
Electrical engineering	101a	Direct current machinery	3
Electrical engineering	103b	Alternating current mach.	3
Civil engineering	102a	Elementary surveying	3
Civil engineering	104a	Higher surveying	3
Civil engineering	105b	Geodetic surveying	3
Civil engineering	111a	Railway surveying	5
Civil engineering	121	Framed structures	6
Civil engineering	122a	Bridge design	5
Civil engineering	125b	Masonry structures	3
Civil engineering	132a	Materials of construction	3
Civil engineering	133b	Testing laboratory	1
Civil engineering	140a or 140b	Hydraulics	2
Civil engineering	141a	Water power	3
Civil engineering	142b	Water supply	2
Civil engineering	151a	Roads and pavements	2
Civil engineering	152a	Sanitary engineering	2
Civil engineering	191b	Specifications and contracts	1
Civil engineering	199	Thesis	3
		Elective	11
			90

ELECTRICAL ENGINEERING

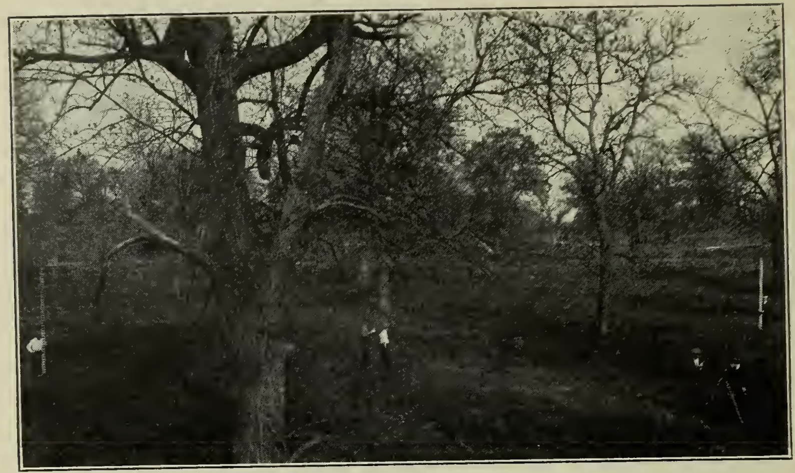
The curriculum in electrical engineering is intended to prepare students for electrical designing, manufacturing, contracting, and for the installation and management of central and isolated electric light stations, power plants and electric railways. It is planned to furnish insight into and appreciation of the complex problems requiring solution by electrical engineers, while giving thorough, broad training.

The technical work consists of the theory and principles of electricity and magnetism; electrical measurements; calibration of instruments; tests of all kinds; design and construction; study of problems in the generation, transmission, distribution, and utilization of electrical energy.

Special attention is paid to alternating current phenomena.

The degree of Electrical Engineer is conferred upon the completion of 90 hours' credit, including the following courses:

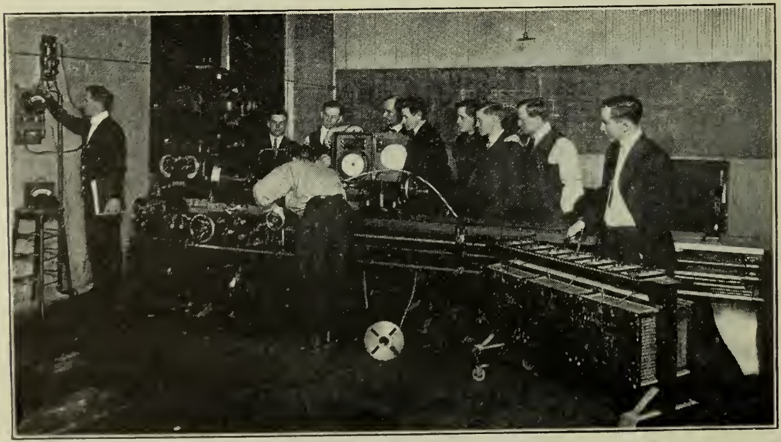
General Subject	No. of Course	Special Title	Hours Credit
Drawing	7a or 7b	Mechanical drawing	3
Drawing	8a or 8b	Machine drawing	2
Mechanics	103	Mechanics of engineering	8
Civil engineering	140a or 140b	Hydraulics	2
Electrical engineering	101a	Direct current machinery	5
Electrical engineering	102b	Adv. direct cur. machinery	3
Drawing	9a or 9b	Descriptive geometry	2
Manual arts	1a or 1b	Woodwork and forging	2
Physics	104a	Electrical measurements	5
Manual arts	2a or 2b	Pattern making	2
Civil engineering	101a	Elementary surveying	2
Mechanical engineering	133	Prime movers	6
Electrical engineering	110a	Elementary alternat. cur.	5
Electrical engineering	111b	Advanced alternating cur.	5
Civil engineering	135b	Materials of construction	2
Electrical engineering	120b	Problems in dir. cur. design	2
Manual arts	3	Machine work	4
Electrical engineering	106	Seminar	2
Mechanical engineering	123	Mechanical laboratory	2
Civil engineering	191b	Specifications and contracts	1
Electrical engineering	121a	Problems in alternat. cur. design	2
Electrical engineering	130a	Generation and ditribution	4
Electrical engineering	140b	Central station practice	2
Electrical engineering	141b	Electric railway engineering	2
Electrical engineering	199	Thesis	3
		Electives	12
			90



A Group in Surveying.

MECHANICAL ENGINEERING

The curriculum in mechanical engineering is intended to fit young men to secure the greatest advantage from the practical experience which must precede, accompany or follow such a study of the applications of the sciences in a profession; and to enable them to be of earlier and greater responsible value in connection with engineering properties—as designers,



Experimental Lathe.

installing engineers, in testing and inspection work, in engineering salesmanship or other associated specialties, in power plant operation, in manufacturing, in efficiency improvement, and in the conception, organizing and direction of extended mechanical industrial enterprises.

The degree of Mechanical Engineer is conferred upon the completion of 90 credit hours, including the following courses:

General Subject	No. of Course	Special Title	Hours Credit
Drawing	7a or 7b	Mechanical drawing	3
Drawing	8a or 8b	Machine drawing	2
Drawing	9a or 9b	Descriptive geometry	2
Manual arts	1a or 1b	Woodwork and forging	2
Manual arts	2a or 2b	Pattern making	2
Manual arts	3	Machine work	4
Mechanical engineering	101b	Elementary mechanisms	2
Mechanics	103	Mechanics of engineering	8
Civil engineering	140a or 140b	Hydraulics	2
Mechanical engineering	102a	Materials of manufacture	1
Mechanical engineering	132	Steam machinery	6
Mechanical engineering	121	Elementary mechanical laboratory	4
Mechanical engineering	103b	Elementary machine design	3
Electrical engineering	101a	Direct current machinery.	5
Electrical engineering	103b	Alternating current machinery	3
Civil engineering	101a	Elementary surveying	2
Mechanical engineering	135a	Heat engines	3
Mechanical engineering	122	Advanced mechanical laboratory	4
Mechanical engineering	104a	Advanced machine design.	3
Mechanical engineering	113a	Shopwork engineering	3
Mechanical engineering	137b	Gas engines	2
Civil engineering	124b	Mill structures	2
Civil engineering	191b	Specifications and contracts	1
Mechanical engineering	139b	Steam engineering	5
Mechanical engineering	112b	Scientific discipline	1
Mechanical engineering	199	Thesis	3
		Elective	12
			90

CHEMICAL ENGINEERING

The rapid development of the chemical industries and the ever increasing demand for engineers trained in the fundamental chemical subjects have led to the introduction of courses in chemical engineering. The curriculum outlined is designed to give a broad and thorough training in general engineering subjects, and in theoretical and applied chemistry. Instruction in chemistry continues through the whole length of the curriculum. The general principles of physical science are further emphasized by extended courses in mathematics, physics, and mechanics.

The curriculum aims to implant in the students a scientific method of work. Instruction is given by means of recitations, lectures, laboratory work, and conferences. The electives enable the student to give some attention to specialization, but the prime object is to produce a broadly trained chemical engineer.

The degree of Chemical Engineer is conferred upon the completion of 90 hours' credit, including the following courses:

General Subject	No. of Course	Special Title	Hours Credit
Chemistry	27a or 27b	Qualitative analysis	5
Drawing	7a or 7b	Mechanical drawing	3
Drawing	8a or 8b	Machine drawing	2
Mechanics	103	Mechanics of engineering	8
Civil engineering	140a or 140b	Hydraulics	2
Chemistry	111	Organic chemistry	6
Mechanical engineering	101b	Elementary mechanisms	2
Drawing	9a or 9b	Descriptive geometry	2
Electrical engineering	101a	Direct current machinery	5
Chemistry	121	Quantitative analysis	6
Physics	104a	Electrical measurements	5
Chemistry	131	Physical chemistry	6
Electrical engineering	103b	Alternating current machinery	3
Mechanical engineering	103b	Elementary machine design	3
Chemistry	141a or 141b	Industrial chemistry	3
Chemistry	122a	Technical analysis	3
Mechanical engineering	133	Prime movers	6
Mechanical engineering	123	Mechanical laboratory	2
		Thesis	3
		Elective	15
			90

STATEMENT OF COURSES

Courses designated by a number with the letter *a* attached, thus: 100a, are given the first semester only. Those designated by a number with the letter *b* attached, thus: 100b, are given the second semester only Those designated merely by a number are continuous courses and are given both semesters. Courses numbered 200 and above are strictly graduate in character. *Arabic numerals in parenthesis indicate the number of hours credit a semester.* A full description of courses will be found in the annual catalogue which may be obtained by addressing the Dean of the University Faculty, University of Missouri, Columbia, Missouri.

A schedule of recitations, lectures and laboratory work may be had upon application to the Registrar after August 1st.

ENGINEERING

10a or 10b. **Elementary Automobile Engineering.** (no credit) Mr. Fessenden.

CIVIL ENGINEERING

Topographical Engineering

101a or 101b. **Elementary Surveying.** (2). Mr. Williams.
102a or 102b. **Elementary Surveying** (3). Mr. Williams.
104b. **Higher Surveying** (3). Mr. Williams.
105b. **Geodetic Surveying.** (3). Mr. Williams.
106a. **City Planning** (2). Mr. Williams.
201. **Geodesy and Precise Surveying.** Mr. Williams.

Railway Engineering

111b. **Railway Surveying** (5). Mr. Miller.
112b. **Railway Engineering** (3). Mr. Miller.
114a. **Railway Maintenance** (3). Mr. Miller.
115b. **Railway Yards and Terminals** (2). Mr. Miller.
116b. **Signaling and Interlocking** (2). Mr. Miller.
211. **Railway Engineering.** Mr. Miller.

Structural Engineering

121. **Framed Structures** (3). Mr. Hyde.
122a. **Bridge Design** (5). Mr. Hyde.
123b. **Higher Structures** (3) Mr. Hyde.
124b. **Mill Structures** (2). Mr. Hyde.
125b. **Masonry Structures** (3). Mr. Spalding.
126a. **Concrete Structures** (2) Mr. Spalding.
221. **Bridge Engineering.** Mr. Hyde.
222. **Concrete Structures.** Mr. Spalding; Mr. Hyde.

Materials of Construction

132a. **Materials of Construction** (3). Mr. LaRue.
133b. **Testing Laboratory** (1). Mr. LaRue.
134b. **Testing Road Materials** (1). Mr. LaRue.
135b. **Materials of Construction** (2). Mr. LaRue.

Hydraulic Engineering

140a or 140b. **Hydraulics** (2). Mr. Rodhouse.
141a. **Water Power** (3). Mr. Rodhouse.
142b. **Water Supply** (2). Mr. Rodhouse.
143a. **Irrigation and Drainage** (2). Mr. Rodhouse.
144b. **Rivers and Canals** (2). Mr. Rodhouse.
145b. **Hydraulic Design** (2). Mr. Rodhouse.
241. **Hydraulic Engineering.** Mr. Rodhouse.

Municipal Engineering

151a. **Roads and Pavements** (2). Mr. Spalding.
152b. **Sanitary Engineering** (2). Mr. Spalding.
153a. **Sewerage** (2). Mr. Rodhouse.
154b. **Municipal Sanitation** (2). Mr. Spalding.
155a. **Highway Engineering** (2). Mr. Spalding.
156b. **Highway Structures** (2). Mr. Spalding.
157b. **Sanitary Design** (2). Mr. Spalding.
251. **Sanitary Engineering.** Mr. Spalding.

General

191b. **Specifications and Contracts** (1). Mr. Spalding.
199. **Thesis** (1, first semester; 2, second semester).

ELECTRICAL ENGINEERING

101a. **Direct Current Machinery** (5). Mr. Weinbach; Mr. Atkinson.
102b. **Advanced Direct Current Machinery** (3). Mr. Weinbach; Mr. Atkinson.
103b. **Alternating Current Machinery** (3). Mr. Atkinson.
106. **Seminar** (1). Mr. Kellogg.
110a. **Elementary Alternating Currents** (5). Mr. Kellogg.
111b. **Advanced Alternating Currents** (5). Mr. Kellogg; Mr. Gumaer.
120b. **Problems in Direct Current Design** (2). Mr. Gumaer.
121a. **Problems in Alternating Current Design** (2). Mr. Gumaer.
122. **Central Station Management and Operation** (3).
130a. **Generation and Distribution** (4). Mr. Weinbach.

131a. **Electric Motors** (2). Mr. Weinbach.
132a. **Storage Battery Engineering** (2). Mr. Gumaer.
133b. **Illumination** (3). Mr. Atkinson.
134a. **Telephony** (2). Mr. Kellogg.
140b. **Central Station Practice** (2). Mr. Kellogg.
141b. **Electric Railway Engineering** (2). Mr. Weinbach.
142b. **Transmission** (2). Mr. Gumaer.
143b. **Electrical Processes** (2). Mr. Weinbach.
145b. **Costs in Public Service Enterprises** (3). Mr. Kellogg.
199. **Thesis** (1, first semester; 2, second semester).
210. **Applications of Mathematics to Electrical Engineering** (2). Mr. Gumaer.
221. **Advanced Design.**
223. **Electrical Engineering Economics.**

MECHANICAL ENGINEERING

Design

101b. **Elementary Mechanisms** (2). Mr. Billings.
102a. **Materials of Manufacture** (1). Mr. Hibbard.
103b. **Elementary Machine Design** (3). Mr. Hibbard.
104a. **Advanced Machine Design** (3). Mr. Billings.
201. **Special Machine Design.** Mr. Fessenden.

Shop Management

111b. **Engineering Office Work** (1). Mr. Hibbard.
112b. **Scientific Discipline** (1). Mr. Hibbard.
113a. **Shopwork Engineering.** (3). Mr. Hibbard
113b. **Shopwork Engineering** (2). Mr. Hibbard.
114a or 114b. **Hoisting and Conveying Machinery** (2). Mr. Westcott.
115b. **Plants and Processes** (2). Mr. Fessenden.
116a. **Scientific Management** (3). Mr. Hibbard.

Testing and Experimental Engineering

121. **Elementary Mechanical Laboratory** (2). Mr. Wharton.
122. **Advanced Mechanical Laboratory** (2). Mr. Billings.
123. **Mechanical Laboratory,** for electrical and chemical engineering students. (1) Mr. Billings.
124b. **Mechanical Laboratory,** for students in civil engineering (1). Mr. Wharton.
224. **Special Mechanical Laboratory.** Mr. Hibbard; Mr. Westcott; Mr. Wharton.

Power Engineering

131a. **Engines and Boilers** (2). Mr. Wharton.
132. **Steam Machinery** (3). Mr. Fessenden.
133. **Prime Movers** (3). Mr. Hibbard; Mr. Wharton.
134a. **Valve Gears** (2). Mr. Fessenden.
135a. **Heat Engines** (3). Mr. Wharton.
136a. **Steam Turbines** (2). Mr. Fessenden.
137b. **Gas Engines** (2). Mr. Wharton.
138a. **Gas Producers** (2). Mr. Wharton.
139b. **Steam Engineering** (5). Mr. Fessenden.
141b. **Boiler Design** (2). Mr. Fessenden.
231. **Power Generation.** Mr. Hibbard, Mr. Wharton.
236. **Advanced Steam Turbine Design.** Mr. Fessenden.

Power Applications

151b. **Refrigeration** (3). Mr. Wharton.
152a. **Ventilation and Heating** (2). Mr. Fessenden.
153a. **Water Motors** (2). Mr. Wharton.
154b. **Pumping Machinery** (2). Mr. Wharton.
255. **Power Transmission.** Mr. Hibbard.

Railway

161. **Railway Mechanical Engineering.** Mr. Hibbard.
162. **Locomotive Design.** Mr. Hibbard.
261. **Railway Shops and Locomotive Terminals.** Mr. Hibbard.

General

171a or 171b. **Technical Literature** (1). Mr. Hibbard.
199. **Thesis.**
299. **Thesis.**

CHEMISTRY

27a and 27b. **Qualitative Analysis** (5) . Mr. Gibson.

111. **Organic Chemistry** (3). Mr. Jones.

112a and 112b. **Preparation of Organic Compounds.** (2) or (3). Mr. Jones.

113a and 113b. **Preparation of Organic Compounds and Organic Analysis** (3), (4) or (5). Mr. Jones.

121. **Quantitative Chemical Analysis.** (3). Mr. Gibson.

122a. **Technical Analysis.** Gas, Water and Fuel. (3). Mr. Gibson or Mr. Brown.

123b. **Technical Analysis.** Inorganic commercial products. (3). Mr. Gibson or Mr. Brown.

125a. **Quantitative Organic Analysis.** (3). Mr. Jones.

126b. **Quantitative Organic Analysis.** (3). Mr. Jones.
127. **Advanced Qualitative Analysis.** (2). Mr. Gibson.
131. **Physical Chemistry.** (3), (4) or (5). Mr. Schlundt.
133. **Electro-Chemistry.** (3), (4) or (5). Mr. Schlundt.
135a or 135b. **Radioactivity.** (3). Mr. Schlundt.
141a. **Industrial Chemistry.** (3). Mr. Brown.
142b. **Industrial Chemistry.** (2) or (3). Mr. Brown.
151a or 151b. **History of Chemistry.** (3).
200. **Chemistry of the Rare Earths.** (3). Mr. Brown.
211a and 211b. **Advanced Organic Chemistry.** (2) or (3). Mr. Jones.
221. **Advanced Quantitative Analysis.** Mr. Gibson.
231. **Mathematical Chemistry.** (2). Mr. Morlan.
232a and 232b. **Advanced Physical Chemistry.** Mr. Schlundt.
271. **Research.**

MECHANICS

101. **Elementary Mechanics.** (2). Mr. Defoe.
103. **Mechanics of Engineering.** (4). Mr. Defoe.
104. **Elasticity.** (3). Mr. Defoe.
109. **Hydrodynamics.** Mr. Defoe.
120. **Advanced Mechanics.** Mr. Defoe.

MANUAL ARTS

1a or 1b. **Woodwork and Forging.** (1 or 2). Mr. Griffith; Mr. Brigham.
2a or 2b. **Pattern Making.** (2). Mr. Abbott.
3. **Machine Work.** (2). Mr. Brigham.
11b. **Foundry Moulding.** (1). Mr. Abbott.
136. **Advanced Machine Work.** (2). Mr. Brigham.

MECHANICAL DRAWING

4a and 4b. **Architectural Drawing.** (3). Mr. Rodhouse; Mr. Welch.
6b. **Advanced Lettering.** (1). Mr. Welch.
7a and 7b. **Mechanical Drawing.** (3). Mr. Rodhouse; Mr. Welch; Mr. Newton.
8a and 8b. **Machine Drawing.** (2). Mr. Rodhouse; Mr. Welch; Mr. Newton.
9a and 9b. **Descriptive Geometry.** (2). Mr. Welch; Mr. Rodhouse; Mr. Newton.
10a. **Topographical Drawing.** (1). Mr. Welch.
11a and 11b. **Perspective.** (3). Mr. Rodhouse; Mr. Welch.

140. **Advanced Architectural Drawing.** (3). Mr. Rodhouse; Mr. Welch.

141. **Advanced Machine Drafting.** (3). Mr. Newton.

OTHER COURSES

The following courses offered in the College of Arts and Science are of particular interest to students in the School of Engineering:

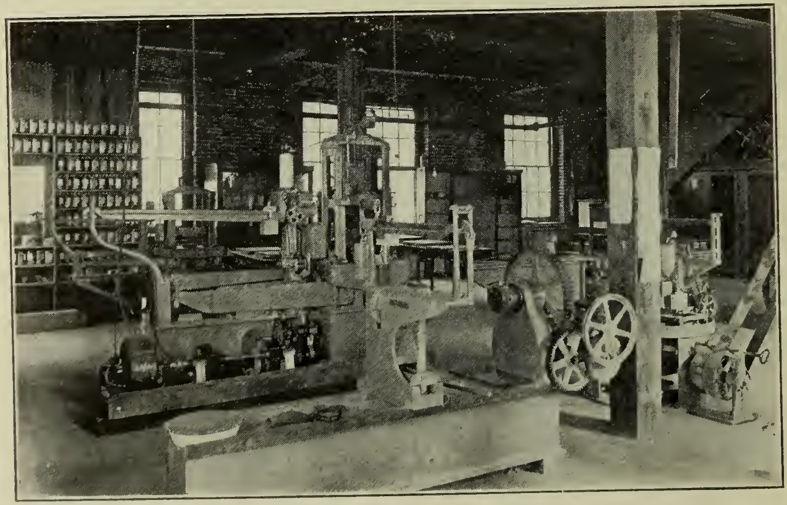
Astronomy. 1a and 1b, descriptive astronomy; 103a geodetic astronomy.

Economics. 1a or 1b, general economics; 110a or 110b, problems of labor; 117a or 117b accounting; 233a or 233b, valuation of public utilities.

Geology. 2a or 2b, physical geology; 4b, rocks and rock minerals; 100a economic geology; 107a, field geology.

Mathematics. 120a and 125b, differential equations and their applications.

Physics. 104a, electrical measurements; 110b, electricity magnetism; 207, theory of electricity and magnetism; 112a, heat; 206, theory of heat; 221b, electrical waves.



Materials Testing Laboratory.

GRADUATE WORK IN ENGINEERING.

Leading to the Degree of Doctor of Philosophy in the Graduate School.

Graduates of the School of Engineering holding professional degrees (C. E., M. E., E. E., Ch. E.) will be admitted to candidacy for the degree of Doctor of Philosophy (Ph. D.) in the Graduate School upon the completion of a minimum of two years of additional work.

Graduates of other schools of engineering in good standing who have completed five years of University work will be admitted on the same basis. A minimum of three years of graduate work will be required of all graduates of other schools of engineering who have completed only four years of university work.

The administrative committee of the Graduate School reserves the right to pass on the qualifications of all candidates.

The graduate student is expected to devote the major portion of his time to research work. A part of the time may be given to some of the advanced courses offered in engineering, or other university courses allied to the main subject of study.

The work of each candidate is under the supervision of a special committee of the faculty, whose function it is to advise the student in regard to his course of study and the subject of his research.

The usual work consists in the investigation of some engineering problem of practical or scientific importance. In this the student is thrown largely upon his own resources, and must show originality and capacity for accurate scientific thinking. The results of the researches are to be embodied in a dissertation which shall give evidence of the merit of the work and the ability of the student. The regulations governing the degree of Doctor of Philosophy are given on pages 344-346 of the catalogue.

The equipment and funds of the engineering experiment station are available for experimental research, provided the subjects being investigated are of such practical importance as to conform to the general purpose for which the experiment station was established.

A limited number of research assistants in the engineering experiment station are appointed each year, and under suitable conditions work carried on by these assistants may count toward the doctor's degree. This makes the research assistantship equivalent to a graduate fellowship, enabling the candidate thus appointed to work toward his degree and at the same time earn his expenses during a part of the time.

For further information regarding graduate work, address Dean of the Graduate School, University of Missouri, Columbia, Missouri.

THE ENGINEERING EXPERIMENT STATION

OFFICERS OF THE STATION

ALBERT ROSS HILL, Ph.D., LL.D., President of the University
EDWIN ALLAN FESSENDEN, B.S. in M.E., M.E., In charge, 1913-14.

The Engineering Experiment Station of the University of Missouri was established by order of the Board of Curators, July 1, 1909.

The object of the station is to be of service to the people of the State of Missouri.

First: By investigating such problems in engineering lines as appear to be of the most direct and immediate benefit and publishing these studies and information in the form of bulletins.

Second: By research of importance to the manufacturing and industrial interests of the state and to engineers.

The staff of the station consists at present of a director and four research assistants together with a number of teachers who have undertaken research under the direction of the station.

Suggestions as to problems to be investigated, and inquiries will be welcomed.

Bulletins have been published as follows:

Vol. 1, No. 1, *Acetylene for Lighting Country Homes*, by J. D. Bowles, Research Assistant, 1909-10.

Vol. 1, No. 2, *Water Supply for Country Homes*, by K. A. McVey, Research Assistant, 1909-10.

Vol. 1, No. 3, *Sanitation and Sewage Disposal for Country Homes*, by W. C. Davidson.

Vol. 2, No. 1, *The Heating Value and Proximate Analysis of Missouri Coals*, by C. W. Marx and Paul Schweitzer. (A reprint.)

Vol. 2, No. 2, *Friction and Lubrication Testing Apparatus*, by Alan E. Flowers.

Vol. 2, No. 3, *Tests of Road Materials of Missouri*, by W. S. Williams and Warren Roberts.

Vol. 3, No. 1, *The Use of Metal Conductors to Protect Buildings from Lightning*, by E. W. Kellogg.

Vol. 3, No. 2, *Firing Tests on Missouri Coal*, by H. N. Sharp, Research Assistant, 1911-12.

Vol. 3, No. 3, *A Report on Steam Boiler Trials Under Operating Conditions*, by A. L. Westcott.

Vol. 4, No. 1, *Economics of Rural Distribution of Electric Power*, by L. E. Hildebrand, research assistant, 1912-13.

Vol. 4, No. 2, *Comparative Tests of Cylinder Oils*, by M. P. Weinbach.

Vol. 4, No. 3, *Artesian Waters of Missouri*, by A. W. McCoy, research assistant, 1912-13.

Vol. 4, No. 4, *Friction Tests on Lubricating Grease and Oils*, by A. L. Westcott.

The following studies are now in progress:

Coal testing.
Deep wells and deep well pumping.
Fire and accident prevention.
Artificial illumination.
Economics of electric cooking.
Transmission of heat through boiler surface.
Effect of size and quality of sand upon cement mortar.
Strength and heat resisting qualities of igneous rocks.
Missouri clays.
Water power in Missouri.
Metallic alloys.

besides a number of detailed studies of materials and processes and investigations of Missouri's natural resources.

A standardizing laboratory has been established and part of the apparatus is now available.

Any resident of the state may, on request, obtain bulletins as issued or if particularly interested, may be placed on the regular mailing list. Address DIRECTOR ENGINEERING EXPERIMENT STATION, UNIVERSITY OF MISSOURI, COLUMBIA, MISSOURI.

STUDENT ACTIVITIES

Notwithstanding a very strong *esprit de corps* among the students of the School of Engineering, they are keenly interested in all of the activities of the general student body and the enterprises common to student life.

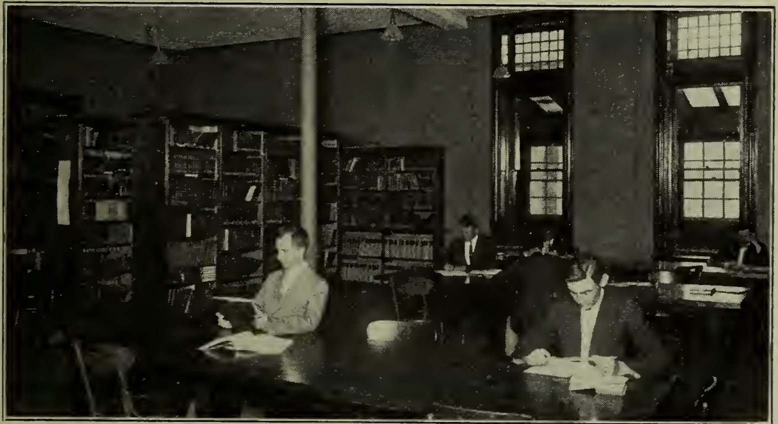
ENGINEERING SOCIETIES

Branches of two national engineering societies, the American Institute of Electrical Engineers and the American Society of Mechanical Engineers have been established for several years. Meetings of each are held semi-monthly for the discussion of current engineering problems, usually drawn from the publications of the national societies received regularly by the members of the branches. Practically all of the upper

Engineers' Parade.

classmen in electrical engineering and mechanical engineering are active members of one or the other of the branches and a great deal of interest is taken in the meetings. These societies are strongly encouraged because of the benefits to be derived from practice in preparing and delivering papers before a critical audience and for the acquaintance with the activities of the prominent engineers composing the national societies.

During 1913, the Civil Engineers' Society, working along lines similar to those followed by the branches discussed above, was organized. This society is not affiliated with a national society, however.



Engineering Library.

ATHLETICS

Students in all divisions of the University are encouraged to take part in athletics in one form or another. Class teams and Varisty teams are maintained in football, baseball, basketball, tennis, track work. These are all very carefully supervised and under the direction of the experienced coaches and trainers.

Rothwell Gymnasium is a stone building only a few years old. The gymnasium room is well lighted and well ventilated and equipped with the usual apparatus. Bathing, locker, and dressing facilities are provided in the basement. During good weather much of the systematic work is carried on in an outdoor gymnasium arranged near Rothwell Gymnasium.

"Rollins Athletic Field," named in recognition of the generosity of members of the Rollins family, is just west of Rothwell Gymnasium. It contains a quarter mile cinder track, a 220-yard straight away, grounds for field athletics, a gridiron for football and a baseball field. All intercollegiate contests are held here.

Concrete bleachers which seat 4,250 persons were constructed last summer. A new concrete fence with ornamental gate partially surrounds Rollins Field.

Tennis courts, basketball courts, baseball, football, and soccer fields for all students are situated near the gymnasium.

A nine-hole golf course is open to the faculty and all students.

EMPLOYMENT BUREAU

The School of Engineering has always made an effort to secure employment for its graduates. No difficulty is experienced and practically all of the senior class have positions before Commencement Day. This year there are more opportunities than men to fill them.

Inquiries for men to fill advanced positions requiring more or less special experience are occasionally received. A file showing the records of graduates as they are received from time to time on blanks sent them for the purpose, often makes it possible to recommend men particularly fitted for these positions.

About a year ago record blanks were sent to all of the graduates of the School of Engineering whose addresses were known, about 630 in all. At the time this is being written replies have been received from 286. These records show that they are employed as follows:

Employment	Graduates in				
	Civil Engineering	Mechanical Engineering	Electrical Engineering	Chemical Engineering	Total
Manufacturing Company					
Pres., V-pres., or owner	1		3		4
Asst. gen. supt., dept. supt., asst. dept. supt.	1	2	3	1	7
Chief engineer		2	1		3
Engineer		3	2		5
Apprentice		2	2		4
Testing dept.		4	8		12
Design		1	4		5
Telephone Company					
Assistant chief engineer			1		1
Asst. dept. supt			1		1
Engineer	2		4		6
Mining					
Mine superintendent	1				1
Mining engineer or elec.	1	1	2		4
Heat, Light and Power Sta.					
Supt., asst. and dist. supt.		5	10		15
Asst. chief engineer and engineer in plant	1	1	16		18
Design & construction	2		4		6
Apprentice			4		4
Steam and Electric R. R.					
Vice-president	1				1
Chief engineer			1		1
Gen. mgr. & gen. supt.			1		1
Dept. superintendent	1				1
Engineer and asst. eng.	10		1		11
Contraction work, bridges, canals, drainage, etc.					
Members of company and chief officers	12		2		14
Dist. engineer and engineer on work	38		1		39
Asst. & jr. engineer	8				8
Asst. chief engineer	1				1
Forward	80	21	71	1	173

Employment	Graduates in				
	Civil Engineering	Mechanical Engineering	Electrical Engineering	Chemical Engineering	Total
Brought forward	80	21	71	1	173
Superintendent.........	4				4
Municipal Work					
City engineer or asst. city engineer.............	12	1			13
Highway engineer.......	6				6
Teaching					
Associate professor......	2	1			3
Assistant professor......		1			1
Instructor.............	4	1	2		7
Supt. of high school.....	1				1
Miscellaneous......					
Photographer..........	1				1
Agricultural pursuits....	5		1		6
Banking..............	2				2
Law..................	1				1
Medicine.............	1				1
Fiction writing.........			1		1
Consulting engineer.....	1	1	3		5
Army engineering.......	1				1
Insurance.............			1		1
Draftsmen............	16	1	3		20
Surveyors.............	18				18
Advertising...........			1		1
Chemists..............				8	8
Dealer in engineering equipment..........			1		1
State public service commission.............	1		1		2
Auditors and accountants			3		3
Inspectors.............	2		3		5
Asst. physicist, U. S. Bureau of Standards..			1		1
Total of all men heard from	158	27	92	9	286

FEES AND EXPENSES

Tuition. Tuition is free in all divisions of the University to students who are residents of the state. Non-residents of the state are required to pay a tuition fee of $10 a semester in all divisions of the University, except in the Graduate School.

Library, Hospital and Incidental Fee. All students in the University except those enrolled in the Summer Session and in the Short Winter Courses in Agriculture, and except those specially exempt by law or by rule of the Curators,* are required to pay a library, hospital and incidental fee of $10 a semester.

Laboratory Deposits. Each student entering a laboratory is required to make a deposit of $5, unless a different amount be fixed by the President and the director of the laboratory. From the amount deposited there is deducted a fixed charge (in no case less than $1, for each individual laboratory course), and also all charges for materials used or for damages to or loss of University property. If the deposit is insufficient to cover all such charges the student is required to make an additional deposit or deposits. When damage or loss is suffered by a laboratory, it is assessed against the deposits of students using the laboratory at time of the damage or loss, unless such damage or loss can be traced to some individual student or students. The remainder of any deposit, after payment of all charges, is refunded to the student at the end of his laboratory course in any session, provided it be called for within twenty days after the close of the session. If not so called for, the amount will be credited to the laboratory in which deposit was made.

All fees and deposits must be paid in advance.

Books and Instruments. The cost of books varies considerably depending upon the courses being taken each year; a fair average is from $20 to $30 a year. A good set of drawing instruments is required in the first year's work in mechanical drawing and is used throughout the course. This should cost from $10 to $20 depending upon the quality.

Room Rent and Board. Rooms may be rented in Benton and Lathrop Halls, the University dormitories for men, at from $20 to $35 for each student for a session of 38 weeks. Two students occupy each room and the rent depends upon the location of the room.

For rooms in private houses from $8 to $16 a month is charged, the average being about $12. This is usually shared by two students.

The Commons, run under the direction of the University, consists of the club dining room and the cafeteria, both in Lathrop Hall. Board in the dining room is about $2.50 a week. The average cost of meals served in the cafeteria is 13 cents.

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*See the annual catalogue.

Board in private boarding houses usually costs from $3.50 to $5. a week. Private boarding clubs are formed in which the average cost is about $3 a week.

Total Expenses. The table below is intended to give an idea as to the probable yearly expenses of a student in the School of Engineering.

	Low Estimate	Medium Estimate	Very Liberal Estimate
Library, hospital and incidental fee*...	$20.00	$20.00	$20.00
Room rent........................	23.00	50.00	90.00
Board............................	95.00	133.00	190.00
Laboratory deposits................	15.00	20.00	30.00
Books............................	15.00	25.00	35.00
Laundry..........................	18.00	35.00	50.00
Society dues and assessments.........	2.00	10.00	25.00
Incidentals, amusements, etc.........	22.00	47.00	100.00
	$210.00	$340.00	$540.00

Clothing and railroad fares are not included in this table. The actual expenditures will depend largely upon the tastes and inclinations of the individual student. The low estimate in the table is considered to be about the minimum amount required consistent with comfortable quarters and good food. It implies rigid economy in all things. The medium estimate is thought to be about the average amount spent by students in the School of Engineering.

There are many opportunities for a student to earn money to pay part or all of his expenses at Columbia. The Y. M. C. A. conducts an employment bureau to aid students in finding work of this kind. Students who must spend part of their time in outside employment should not expect to take full work in the University and under these circumstances an additional year is often required to satisfy the requirements for graduation. Students coming to Columbia for the first time should not expect to find work at once, but must have some funds available to meet necessary expenses until employment is obtained. This may require several months.

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*Under certain conditions students are exempt from the library, hospital and incidental fee. For particulars, see the annual catalogue.

INFORMATION ABOUT THE UNIVERSITY

GENERAL STATEMENT

The fundamental aim of the University of Missouri is the development of the highest and most efficient type of citizen. For the purpose of attaining its aim, the University furnishes ample facilities for liberal education and for thorough professional training. The University is a part of the public educational system of the State.

In the course of seventy-five years of development, new divisions of instruction have been organized in response to the needs of vocations followed by citizens of the state.

ORGANIZATION

The work of the University is now carried on in the following schools and colleges:

College of Arts and Science
College of Agriculture
School of Education
School of Law
School of Medicine
School of Engineering
School of Mines and Metallurgy
School of Journalism
School of Commerce
Graduate School
Extension Division

All of these divisions are at Columbia with the exception of the School of Mines and Metallurgy, which is located at Rolla. In addition, emphasis is given particular lines of work by the establishment of minor divisions, the chief of which are the Agricultural Experiment Station, Engineering Experiment Station, and the Military School.

LOCATION

The University of Missouri is located at Columbia, a town situated half way between St. Louis and Kansas City near the center of the State. It is reached by the Wabash and the Missouri, Kansas and Texas Railways. Columbia is a progressive and prosperous town having doubled its population in the last few years. It has nearly twenty miles of paved streets.

Columbia may be characterized as a town of schools, homes and churches, with enough of industrialism to make it efficient. It offers the conveniences of a larger city without the counter attractions. The student is a predominant factor in Columbia. He is one to three in numbers. The population of the town is 12,000.

EQUIPMENT

The University grounds cover more than 800 acres. The main divisions are in the west campus, the east campus, the athletic fields, and the agricultural college farm.

The following University buildings are located at Columbia: Academic Hall; Laws Observatory; separate buildings for chemistry, physics zoology and geology, law, engineering, manual arts, biology; two power houses; Medical Laboratory Building; Parker Memorial Hospital; Agricultural Building; Horticultural Building; green houses; Live Stock Judging, Dairy, Farm Machinery, Poultry and Veterinary Buildings; the agricultural college farm barns and buildings; Switzler Hall, for the School of Journalism; Benton and Lathrop Halls, dormitories for men; Read Hall and Sampson Hall, dormitories for women; Rothwell Gymnasium; the houses for the president of the University and the dean of the College of Agriculture; the High School and the Elementary School Buildings; and the Gordon Hotel Building for home economics.

FOR FURTHER INFORMATION

Full information regarding the University is given in the catalogue which will be sent on request without charge. For this or special bulletins of the Graduate School, College of Arts and Science, College of Agriculture School of Education, School of Journalism, School of Commerce, and Extension Division, write to

Dean, University Faculty,
University of Missouri,
Columbia, Missouri

UNIVERSITY CALENDAR

AT COLUMBIA

Summer Session

1914	
June 11	Thursday, registration.
June 12	Friday, organization of classes.
July 4	Saturday, holiday.
August 6	Thursday, lectures close.
August 7	Friday, examinations.
August 8	Saturday, entrance examinations.

First Semester

September 14, 15, 16,	Monday, Tuesday and Wednesday, entrance examinations and registration.
September 17	Thursday, 8 a. m., class work in all divisions begins
September 17	Thursday, 10 a. m., opening convocation.
October 1	Thursday, quarterly meeting of curators.
November 3	Thesday, election day, holiday.
November 26	Thursday, Thanksgiving, holiday.
December 15	Tuesday, annual meeting of curators.
December 18 1915 January 4	Friday, 4 p. m. to Monday, 8 a. m. } Christmas holidays.
January 23 January 30	Saturday to Saturday } Mid-year examinations.
January 28, 29, 30	Thursday, Friday and Saturday, entrance examinations.

Second Semester.

February 1, 2	Monday and Tuesday, registration, second semester.
February 3	Wednesday, 8 a. m. class work in all divisions begins.
February 4	Thursday, 10 a. m., opening convocation.
February 22	Monday, Washington's Birthday, holiday.
April 1	Thursday, quarterly meeting of curators.
April 1 April 7	Thursday, 4 p. m. to Wednesday, 8 a. m. } Easter holidays.
May 30	Sunday, baccalaureate address.
May 31, June 1	Monday and Tuesday, senior class exercises.
June 2	Wednesday, alumni day.
June 3	Thursday, commencement day.
June 3	Thursday, semi-annual meeting of curators.
June 4 June 11	Friday to Friday } Final examinations.

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THE
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BULLETIN

VOLUME 15

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EDITED BY
HUGH J. MACKAY
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VOLUME 16 NUMBER 8

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1915, No. 4

ANNOUNCEMENT
OF THE
SCHOOL OF ENGINEERING
1915-1916

UNIVERSITY OF MISSOURI
COLUMBIA, MISSOURI
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UNIVERSITY OF MISSOURI
COLUMBIA, MISSOURI
March, 1915

Main Engineering Building

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UNIVERSITY CALENDAR

AT COLUMBIA

Summer Session

1915		
June 10	Thursday, registration	
June 11	Friday, organization of classes	
August 6	Friday, examinations	
August 7	Saturday, entrance examinations	

First Semester

September 13, 14, 15	Monday, Tuesday, and Wednesday, entrance examinations and registration	
September 16	Thursday, 8 a. m., class work in all divisions begins	
September 16	Thursday, 10 a. m., opening convocation	
Nov. 1 to Dec. 17	First term, short course in agriculture	
November 25	Thursday, Thanksgiving, holiday	
December 17	Friday, 4 p. m., to	Christmas holidays
1916		
January 4	Tuesday, 8 a. m.	
Jan. 10 to Feb. 26	Second term, short course in agriculture	
January 22	Saturday, to	Mid-year examinations
January 29	Saturday	
January 27, 28, 29	Thursday, Friday, and Saturday, entrance examinations	

Second Semester

Jan. 31, Feb. 1	Monday and Tuesday, registration, second semester	
February 2	Wednesday, 8 a. m., class work in all divisions begins	
February 3	Thursday, 10 a. m., opening convocation	
February 22	Tuesday, Washington's Birthday, holiday	
April 19	Wednesday, 4 p. m., to	Easter holidays
April 25	Tuesday, 8 a. m.	
May 28	Sunday, baccalaureate address	
June 1	Thursday, commencement day	
June 2	Friday, to	Final examinations
June 9	Friday	

The Modern Engineer

In 1828 the Institution of Civil Engineers was organized in London. In the charter of the Institution, civil engineering was defined as the "art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states, both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation and docks for internal intercourse and exchange, and in the construction of harbors, moles, breakwaters and light houses, and in the art of navigation by artificial power for the purpose of commerce, and in the construction and adoption of machinery, and in the drainage of cities and towns."

For many years this definition has been a classic, regarded as expressing a definite view of the field covered by engineering practice. Many changes have occurred since the organization of the great Institution, and the enumeration of lines of work might be considerably modified and extended if it were to be written at the present time. To prepare a complete statement of what constitutes the entire field of engineering would be a large task, and it is only proposed here to give some brief account of the various fields of activity in which engineers may be engaged, and of the demands of practice upon the modern engineer.

HISTORICAL SKETCH

Previous to the middle of the eighteenth century, engineering was applied almost exclusively to the purposes of war. In a few instances public works intended for other purposes were constructed, but usually the engineers were military officers and the works executed by soldiers. About this period, however, a new class of engineers appeared, who concerned themselves with works of much the same character, but not military in purpose and not executed by soldiers. These men were known as "civil engineers" to distinguish them from the "military engineers." The increase in urban population and development of trade made a demand for public works, and for machinery, which soon caused the importance of the new profession to be recognized, and the number of its members to rapidly increase.

During this early period there was no division of the field of engineering into specialties. Civil engineers covered the whole range of works included in the definition. Among these early engineers were a number of very able men, who with but little training in the laws of science, and without precedents of practice to guide them, succeeded in accomplishing difficult engineering feats, and in establishing a safe and rational practice.

About the middle of the nineteenth century the industrial development which followed the invention of the steam engine had so widened the field of engineering practice, and so increased the demands upon the engineering profession, that a single engineer could no longer cover the whole range of practice, and engineers began to devote their attention to more restricted lines of work. This resulted in dividing engineers into classes, each devoting its attention to a special field.

DIVISION INTO SPECIALTIES

The demand for motor power and machinery for industrial enterprises and transportation caused many engineers to devote themselves exclusively to such work. These men were called "mechanical engineers" and soon were recognized as a distinct branch of the profession. The term civil engineer was still applied to those not primarily concerned with the production or operation of machinery.

Almost immediately following the establishment of mechanical engineers into an independent profession, mining engineering became in the same way a separate branch. The demand for metals and coal consequent upon the industrial development already mentioned caused many engineers to devote their whole attention to the opening and operation of mines. These were called "mining engineers."

Near the close of the nineteenth century the discovery of methods of applying electricity to numerous uses and the consequent immense development of electrical plants and appliances caused many men to devote their attention primarily to electrical work. These men were recognized as a distinct branch of the profession and called "electrical engineers."

Recently the development of chemical industries has created a demand for men who give their attention primarily to the construction and operation of plants for manufactures in which chemical processes play a leading part. These men are called "chemical engineers."

At present these five divisions of engineering practice are commonly recognized as distinct professions, or as distinct branches of the engineering profession. Schools of engineering commonly give separate curricula leading to degrees in each of these divisions, and while much of the training necessary to make an engineer is common to several or all of them, each engineer is usually recognized as belonging in one division, and limits his practice to his special branch.

The field of engineering practice is constantly widening. Great changes have taken place during the last few years in the standards of living of the people; urban populations have grown rapidly; manufacturing industries have greatly increased in number and become more diversified. The result of all this has been to make larger demands for the services of the engineer and to enlarge the scope of his activities. This growth has naturally caused a further subdivision of the various branches of engineering practice into narrower specialties, not usually recognized as separate professions, but each offering a sufficient opportunity for the exercise of the best endeavors of the men who follow them.

CIVIL ENGINEERING

The term civil engineering is still often used in its original sense as covering all engineering not military, but commonly it is limited to those fields of practice not included in the other branches.

In the number of special fields of work included, it is much the broadest branch of engineering practice. It comprises:

Stream Measurement

Surveying, which in simple forms is used by all civil engineers, but which when applied in geodetic and topographic work may constitute a distinct field of practice.

Hydraulic engineering, which includes the design and construction of harbors and docks; river improvements, canals, irrigation works, drainage and flood prevention, and water power projects.

Sanitary engineering, covering all works designed to protect the public health, such as water supply and water purification, sewerage and sewage disposal, and the disposal of garbage and refuse.

Highway engineering, in which may be included both the maintenance and improvement of country roads and the construction and maintenance of city streets and pavements.

Railway engineering, which deals with the design, construction and maintenance of all works required for steam and electric railways.

Structural engineering, which is concerned with the design and construction of bridges and of the structural features of large buildings that carry heavy loads; masonry and concrete structures, and heavy foundations.

General construction, under which head may be included the execution of large works of construction, and the transportation and handling of heavy materials.

MECHANICAL ENGINEERING

The term mechanical engineering is usually employed to designate the work of those engineers who have to do primarily with steam or other engines, machine tools, mill work and moving machinery in general. The lines of work included in the practice of a mechanical engineer may be:

Power engineering, which consists in the design, construction, and operation of machines and plants for the generation of power. These may include steam, gas, oil, or other engines, with all the auxiliary appliances necessary to their operation, as well as the various methods of power distribution.

Design of plants and machinery for the utilization of power, requiring the study of special processes for which machinery may be required, and the adaptation of machines and arrangement of plants for purposes of economical production.

Shop management, dealing with the control and management of shops in the operation of manufacturing plants.

Gas engineering, covering the production, distribution, and utilization of gas for light, heat, and power purposes.

Railway mechanical engineering, consisting of the design, construction, and operation of rolling stock and other machinery, and of the shops required in the operation of railways.

ELECTRICAL ENGINEERING

Engineers who are concerned mainly with the generation, transmission, or utilization of electrical energy are known as electrical engineers.

The last few years have seen a very great increase in the applications of electricity and the field of its usefulness is constantly widening. The special fields of most importance into which electrical engineering is divided are:

The design and construction of generators, motors and other apparatus required in the generation, distribution and utilization of electric power.

The design, construction and operation of plants for generating electric power and lines for its transmission.

The application of electricity to industrial power.

The building and operation of electric railways.

The utilization of electric energy for lighting purposes.

The design, construction and operation of telephone and telegraph systems.

The application of electricity in the various chemical industries.

CHEMICAL ENGINEERING

Engineers with special training in chemistry, who devote themselves to the development of the various chemical industries, are known as chemical engineers. Much of recent progress is due to the discovery and development of new materials and compounds with characteristics that make them valuable in the arts. A great part of the research being carried on for commercial purposes lies along these lines. A man who has had a thoro training in chemistry, and who combines with his knowledge of chemistry an insight into physical and mechanical problems and an appreciation of the commercial significance of his work, is best qualified to make himself valuable in investigation of this kind. Not only the discovery of new products, but the maintenance of a standard of quality in manufactured materials, demands the labor of men who have a knowledge of chemistry.

This field of work is rapidly becoming very large because of the many and varied industries which have been and are being developed.

RELATION OF ENGINEERS TO SOCIETY

Attention has already been called to the great changes which have taken place in the status of the engineering profession in consequence of the development of industries and the altered standards of living during the past century. These improved social conditions are, for the most part, the result of the work of the engineer. The discoveries of modern science as applied in engineering practice have worked miracles for the better health, comfort, and convenience of modern life.

The invention and perfection of the steam engine was followed by the development of the factory system, making possible the supply of all kinds of manufactured articles at low cost. Then came the steamboat and railroads as methods of transportation, gas for illumination, and the telegraph for quick communication, later all the various electric appliances, and, in our cities, water supply, paving, and sewage disposal. These things have changed the whole aspect of life, both in city and country, and have made the engineer absolutely essential to modern progress.

In view of the enormously important part which the engineer plays in the life of today, it is very necessary that he should be well trained and fully prepared to meet the responsibilities which rest upon him. In a state possessing immense natural resources, capable of development to a position of great wealth and power, and of providing occupation and homes for a large population, it is highly important that there be found a body of engineers able to direct this development in the best way, that resources may be conserved, and improvements economically made. It is also important that the youth of the state have opportunity to make the best of themselves in whatever field of endeavor may be most attractive to them. It is therefore the duty of the School of Engineering to provide a thoro and adequate training for the young men who seek to be engineers, and to maintain a high standard of admission to the profession.

OPPORTUNITIES FOR ENGINEERS

There are good opportunities in engineering practice for able and well trained men. Success in engineering depends upon close application and wide experience. It is a strenuous occupation and holds forth no inducements to the man who is looking for an easy way to make a living. During the last few years usually there have been more openings for graduates than men to fill them. Entrance into engineering work has been easy for the man who has shown energy and ability as a student. After entrance into practice, the future of the engineer depends upon himself. There is opportunity of advancement for the man whose training has developed capacity for work, and who has interest in his work. The financial rewards are not great usually, although the more successful men have little cause for complaint. The true engineer has enthusiasm for his work. Opportunity for service is more to him than personal gain.

The largest field for engineering practice is in the service of various corporations. A few engineers, after obtaining considerable experience, are able to practice as independent consulting engineers, or as designing engineers for special lines of work. Many leave the technical side of engineering work and take up administrative positions, or become connected with the business side of industrial enterprises. Remuneration is commonly greater in such work than in the purely technical work of engineering design.

The rapid growth of public interest in the affairs of corporations controlling public utilities emphasizes a field of work which is peculiarly suitable for engineers. In this and many other states, public service commissions have been established having much power in the regulation of the business of public service corporations. For example, they may fix rates and enforce standards of quality, quantity and service; they may authorize bond issues or forbid them, depending upon the financial condition of the corporation. In the exercise of these and other functions, the commissions need the services of well trained engineers as do also the corporations affected by the commissions. To be fitted for work of this nature, the engineer must not only be well equipped with technical knowledge but must also thoroly understand and appreciate the legal, economic, commercial, social, and ethical questions involved in problems of valuation, and rate fixing.

Rebuilding a Planer in the Machine Shop

Another field of activity for engineers is suggested in the increasing tendency of municipalities to own and operate their electric light and power, water and gas plants. Heretofore the work of the municipal engineer has been largely confined to planning and overseeing the construction and maintenance of streets and pavements, sewers, parks, water mains. The training necessary to qualify for work of this kind has been best supplied by the curricula in civil engineering. For municipalities owning and operating their public utilities the office of city engineer may be well filled by a mechanical or electrical engineer who has included in his technical training, the proper courses covering surveying, streets, pavements, sanitation, sewers, water supply. A student following the regular civil engineering curriculum may prepare for the same field of usefulness by completing courses concerning the principles of steam and electrical machinery and power plants, pumping machinery, lighting and water systems.

THE TRAINING OF ENGINEERS

The education and training of most of the best modern engineers is accomplished by a course of study in a technical school, followed by experience in actual practice. Both are necessary to produce the well equipped engineer. The technical school gives a training in the sciences, and to some extent in the arts which underlie engineering practice. The object should be to develop power in the student to deal with problems involving mathematical and physical sciences, and to cultivate the faculty of independent thought in dealing with such problems.

The fields covered by civil, electrical, mechanical and chemical engineering are so broad and so varied in character that at first it may not be apparent that they possess points in common which cause them to be grouped under a single classification and called engineering. Some of the considerations which are involved in work that is distinctively engineering in character are:

The work must be essentially useful, and those bearing the responsibility must be convinced of its success and utility before it is undertaken.

It has to deal, at some point, with the forces of nature so that the problems involved demand a knowledge of natural laws for their solution. But while some physical, chemical or mechanical problem is always present it is very often necessary to deal with psychological, economic or social factors as well.

Commercial or economic considerations are the determining factors in nearly every engineering problem.

These are some of the features in the problems themselves that make them essentially engineering problems. Engineering has also its characteristic methods, and while these methods may be used by others the engineer is especially at home with them. They involve:

The collection, classification and analysis of data bearing on the problem in hand.

The use of graphical representations of physical laws and characteristics.

The application of known physical laws to the design of apparatus and to the prediction of the action of the thing designed.

Conservatism to insure the building of things for safety and reliability.

The basing of decisions on sound financial policy and ultimate long term economy.

The review of the result and the tempering of the decision in the light of judgment and experience.

These methods of handling problems are sufficiently well defined and systematic to make experience and training along one line valuable in almost any other kind of work. The man who has had good engineering training is exceptionally well fitted to meet and solve problems in any sphere of activity.

The demands of modern engineering practice are for men of broad training. The man who is trained only in the technical side, however thoro may be his acquaintance with the sciences and however skillful he may be in working out the technical features of a design, can not achieve the highest success in his profession. Executive and administrative positions carrying the most responsibility and earning the highest remuneration are frequently best filled by men having engineering training. The duties pertaining to positions of this character are usually more concerned with the commercial rather than the purely technical side of engineering and the qualities which go farthest toward making success are business sense and the ability to deal with people. These qualities are most likely to occur in men whose viewpoint is broad and who can understand and sympathize with the motives and interests of others.

The idea is too prevalent among young men preparing themselves for the practice of engineering that nothing is of importance in such preparation which does not directly concern the technical features of their work and they are even inclined at times to look with disdain upon work in other branches of engineering than their own.

This tendency is usually more marked among those in the earlier stages of preparation than later, when the student has reached a point where he begins to realize something of the real character of the work upon which he is about to enter. It is, therefore, important that those entering upon a course of training in preparation for professional work should be made to realize that breadth of training is necessary. The man who devotes himself exclusively to the technical work of his profession, may become highly skilled in such work. He may be a valuable man in the work with which he is familiar and highly appreciated for his technical skill by the broader man who is chief over him, but he will not be a chief himself. Men develop capacity for directing large affairs by acquiring intimate knowledge of their fellow men and learning how to deal with them. The training and experience of an engineer should give him capacity to direct large business projects, requiring judgment in matters pertaining to engineering. They should make him the logical man to control such enterprises. In order to be fitted for this work, a man must not only be expert in the technical details of the work, but he must have such knowledge of history and such an acquaintance with social and economic laws as to enable him to appreciate the relations of his work to the world about him.

He must, moreover, be able to formulate his ideas concisely and intelligibly, and to present them to others in an agreeable and convincing manner.

These matters should be seriously considered by the young man about to embark on a course of training which is to fit him for the practice of engineering, as well as by those having the direction of students looking forward to such practice.

PRELIMINARY AND TECHNICAL TRAINING

When the student enters the School of Engineering, he spends about two years in the study of arts and science subjects, after which his attention must necessarily be given mainly to the technical courses required for his professional training. These later courses include instruction in the principles of the sciences which underlie engineering practice, and in the applications of these sciences to engineering problems, as well as in the methods employed by engineers in actual practice.

Several methods of instruction are employed depending in each instance upon the character of the work and the purpose with which it is given. Lectures, recitations, and quizzes are used for the purpose of giving a connected development of methods of practice in a given field. Problems in computation and design are employed to show the ways in which scientific principles are applied to engineering problems, to illustrate methods used in practice, and to develop the ability of the student to apply his scientific knowledge to questions arising in engineering design. Laboratory instruction is freely used to illustrate principles outlined in lecture courses, to familiarize the student with the construction and operation of machines or with the behavior of materials, and to develop capacity for independent investigation.

Efficient preparation for practice in any of the branches of engineering requires a broad training in the fundamental applications of science which underlie such practice, as well as some knowledge of the principles and methods of practice in the other fields of engineering. Narrow specialization is never allowable in undergraduate work. Engineering curricula, therefore, are made up mainly of required courses necessary to this fundamental training, but a certain amount of time is usually available for elective work in which a student may study more fully in one of the special lines of practice, or in which he may obtain a wider knowledge of fields of practice outside his own. The way in which elective time may be utilized to the best advantage varies with the preparation of the student and the purpose he has in view. The object should always be to secure symmetrical training, carrying preparation for the special field of practice as far as may be possible without sacrificing breadth of foundation.

The School of Engineering

Instruction in engineering at the University of Missouri began in 1877, when a Chair of Civil Engineering was established in the College of Agriculture and Mechanic Arts, with a curriculum leading to the degree of Civil Engineer. Later, as the demand grew for technically trained men in the more restricted branches, instruction was offered in mechanical and in electrical engineering. In 1907, the engineering departments were separated from the College of Agriculture, and organized as an independent division of the University, known as the School of Engineering. This school now offers four curricula covering a period of five years each leading to the respective degrees of

Civil Engineer
Electrical Engineer
Mechanical Engineer
Chemical Engineer

The object of the several curricula is to provide a broad, thorough and systematic training in the fundamental applications of the sciences which underlie the work of the engineering profession in its different branches, together with some opportunity for specialization by the proper selection of elective courses.

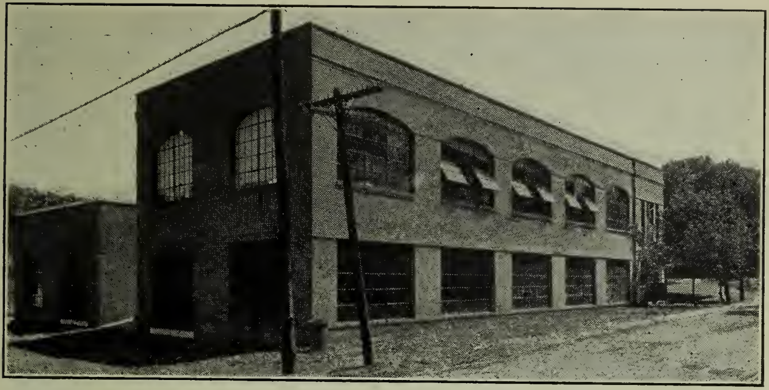
Provision is also made for the conferring of a Bachelor's degree upon the completion of four years of work or a total of 120 hours. See page 27.

BUILDINGS AND EQUIPMENT

The departments of electrical and mechanical engineering occupy the main Engineering Building and the department of civil engineering occupies Switzler Hall. The work in chemistry required of students in chemical engineering is given in the Chemistry Building.

The main engineering laboratories are in the Engineering Annex in the rear of the Engineering Building. A substantial addition to the Engineering Annex is now being used for the expansion of the mechanical engineering laboratory and for the development of a hydraulic laboratory. Shop work is conducted in a building recently erected for the purpose.

Civil Engineering. The laboratory for testing materials is in charge of the department of civil engineering. The equipment includes several vertical testing machines with all the necessary accessories for tension, compression and transverse tests on the ordinary engineering materials, iron, steel, cement, concrete, brick; a beam-testing machine;



Manual Arts Building

a torsion machine; impact and abrasion machines. There is also a complete equipment for all the standard tests upon hydraulic cement.

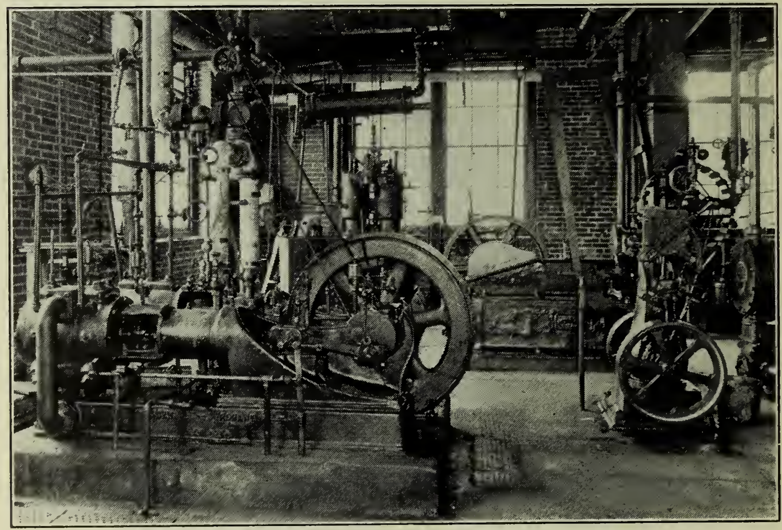
The road materials laboratory contains the necessary machines for making complete tests upon stone for road purposes, a standard rattler for paving brick tests, and the apparatus required in investigating bituminous road materials.

Switzler Hall

There is a good collection of surveying instruments, including the instruments used in ordinary field practice and those necessary for precise surveying and geodetic work.

Stream gages, with a dam and weirs on streams near Columbia, afford opportunity for field study of water supply problems, while practice in hydrographic surveying and stream measurement is obtained by a trip to a river in the neighborhood.

Hydraulic Laboratory. A new hydraulic laboratory has been equipped recently for the study of problems where large quantities of flowing water are needed. Two large size direct-connected electric motor-driven centrifugal pumps have been installed. These pumps will supply water for investigations relating to the flow of water in flumes, large pipes and conduits; to the discharge over dams and weirs, thru racks, sluices and submerged orifices; and to other features encountered in water power and water supply developments.



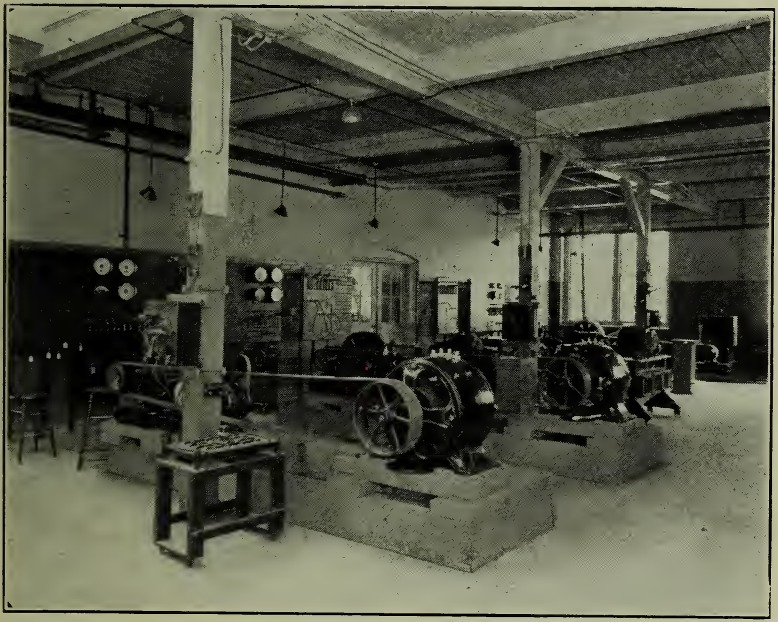
A Corner in the Mechanical Engineering Laboratory

Apparatus for the study of the flow of water thru pipes, fire hose and nozzles, and the effect of valves and bends; for the study of the flow of water thru sand filters, and of ground-water flow in soil drainage; and for the testing of pumping machinery and water wheels.

Full equipment for the accurate measurement of quantities, velocities, and pressures, both in open and closed channels is available, and includes the latest types of Pitot tubes, automatic self-recording gages and water meters.

Mechanical Engineering. The mechanical engineering laboratory contains several different types of steam engines, a small steam turbine with a superheater, condensers, gas engines, reciprocating and centrifugal pumps, a number of fans, blowers, and heating coils for work on ventilation and heating, and a variety of other machinery. Much attention is paid to the study of fuels of all kinds. Complete standard apparatus for determining the analysis and calorific value of coals and gases is provided. The laboratory is supplied with the usual equipment of indicators, gages, water and gas meters, scales, and other necessary accessories.

The central power plant of the University is used for conducting boiler tests under actual operating conditions. Considerable attention is given to the study of refrigeration. Several small ice and cold storage plants belonging to the University are available for tests. A local privately owned plant is also sometimes used.



Part of the Electrical Engineering Laboratory

A high-grade lathe, completely equipped for use in connection with courses in shop efficiency, has been purchased recently. It will be used to make production tests to determine the proper kinds of tools and the best cutting speeds to use in making machine parts.

Electrical Engineering. The electrical engineering laboratory contains direct and alternating current generators and motors of the common types met with in practice, and all the instruments necessary to make complete tests of their operation. Besides several low ratio transformers used in routine exercises, the laboratory has a 10,000 volt transformer for testing dielectric strengths and one of 40,000 volts for high tension experiments. A set of Edison cells and one of chloride cells are available for experiments on storage batteries.

A low voltage motor-generator set is provided for general electrochemical processes, such as electro-plating with gold, silver, nickel, and copper. One large and several small electric furnaces are used for demonstrations of the electric processes involved in the production of carborundum, graphite, emery, calcium carbide, ferro-alloys.

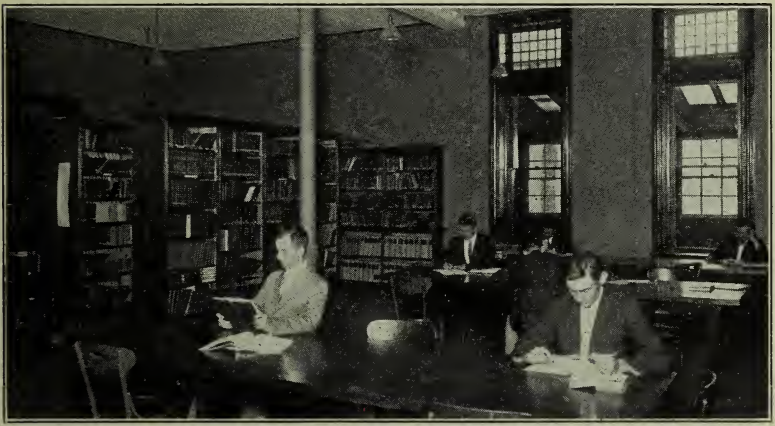
The telephone equipment comprises a demonstration board showing all the apparatus and operations involved in a connection through two offices. For experiments in telephone transmission there is a high frequency generator and an artificial line which is electrically equivalent to fifty miles of underground wire.

Forge Shop

The laboratory also has a quadruplex telegraph set.

Chemical Engineering. In addition to the laboratories in general chemistry, there are separate laboratories for the other fundamental courses in chemistry required in the chemical engineering curriculum. The general analytical laboratory offers facilities for work in qualitative and quantitative analysis. Special work in the technical analysis of fuels, water, gas, and commercial products is given in smaller laboratories equipped especially for these lines of work. Two laboratories are available for general work in organic chemistry, and more advanced work along organic lines is provided for in a furnace room and a laboratory for the preparation of organic compounds. The laboratory in physical chemistry is equipped for work in electrochemistry and measurements in radio-activity. Advanced students have an opportunity to pursue work in metallography. The electrical laboratories in the Engineering Building offer facilities for work in electroplating, storage battery engineering, and electrical processes.

Library. The engineering library in the Engineering Building has 5,000 standard engineering books. These have been very carefully selected and include the works of all of the best American and English engineering authors. About 100 periodicals are regularly received, together with publications recording the transactions of the more important engineering societies.



Engineering Library

Engineering students are permitted free access to the library shelves for reference and are encouraged to draw books for outside reading.

The general library of the University and the library of the State Historical Society together containing about 200,000 books and pamphlets are open to all students in the University.

STUDENT ACTIVITIES

Notwithstanding a very strong *esprit de corps* among the students of the School of Engineering, they are keenly interested in all of the activities of the general student body and the enterprises common to student life.

ENGINEERING SOCIETIES

Branches of two national engineering societies, the American Institute of Electrical Engineers and the American Society of Mechanical Engineers have been established for several years. Meetings of each are held semi-monthly for the discussion of current engineering problems, usually drawn from the publications of the national societies received regularly by the members of the branches. Practically all of the upperclassmen in electrical engineering and mechanical engineering are active members of one or the other of the branches and a great deal of interest is taken in the meetings. These societies are strongly encouraged because of the benefits to be derived from practice in preparing and delivering papers before a critical audience and for the acquaintance with the activities of the prominent engineers composing the national societies.

Engineers' Parade

During 1913, the Civil Engineers' Society, working along lines similar to those followed by the branches discussed above, was organized. This society is not affiliated with a national society, however.

ATHLETICS

Students in all divisions of the University are encouraged to take part in athletics in one form or another. Class teams and Varsity teams are maintained in football, baseball, basketball, tennis, track work. These are all very carefully supervised and under the direction of the experienced coaches and trainers.

Rothwell Gymnasium is a stone building only a few years old. The gymnasium room is well lighted and well ventilated and equipped with the usual apparatus. Bathing, locker, and dressing facilities are provided in the basement. During good weather much of the systematic work is carried on in an outdoor gymnasium arranged near Rothwell Gymnasium.

"Rollins Field," named in recognition of the generosity of members of the Rollins family, is just west of Rothwell Gymnasium. It contains a quarter-mile cinder track, a 220-yard straight away, grounds for field athletics, a gridiron for football, and a baseball field. All intercollegiate contests are held here.

Concrete bleachers which seat 4,250 persons have been constructed. A new concrete fence with ornamental gate partially surrounds Rollins Field.

Tennis courts, basketball courts, baseball, football, and soccer fields for all students are situated near the gymnasium.

A nine-hole golf course is open to the faculty and all students.

EMPLOYMENT BUREAU

The School of Engineering has always made an effort to secure employment for its graduates. No difficulty is experienced and practically all of the senior class have positions before Commencement Day.

Inquiries for men to fill advanced positions requiring more or less special experience are occasionally received. A file showing the records of graduates as they are received from time to time on blanks sent them for the purpose, often makes it possible to recommend men particularly fitted for these positions.

Recently record blanks were sent to all of the graduates of the School of Engineering whose addresses were known, about 630 in all. Up to the time this is written, replies have been received from 286. How these men are employed is shown by the table on page 24.

FEES AND EXPENSES

Tuition. Tuition is free in all divisions of the University to students who are residents of the state. Non-residents of the state are required to pay a tuition fee of $10 a semester in all divisions of the University, except in the Graduate School.

Employment	Graduates in				
	Civil Engineering	Mechanical Engineering	Electrical Engineering	Chemical Engineering	Total
Manufacturing Company					
Pres., V-pres., or owner	1	....	3	....	4
Asst. gen. supt., dept. supt., asst. dept. supt	1	2	3	1	7
Chief engineer	....	2	1	....	3
Engineer	....	3	2	....	5
Apprentice	....	2	2	....	4
Testing dept	....	4	8	....	12
Design	....	1	4	....	5
Telephone Company					
Assistant chief engineer	....	....	1	....	1
Asst. dept. supt	....	....	1	....	1
Engineer	2	....	4	....	6
Mining					
Mine superintendent	1	....	....	....	1
Mining engineer or electrician	1	1	2	....	4
Heat Light and Power Station					
Supt., asst. and dist. supt	....	5	10	....	15
Asst. chief engineer and engineer in plant	1	1	16	....	18
Design and construction	2	....	4	....	6
Apprentice	....	....	4	....	4
Steam and Electric R. R.					
Vice-president	1	....	....	....	1
Chief engineer	....	....	1	....	1
Gen. mgr. and gen. supt	....	....	1	....	1
Dept. superintendent	1	....	....	....	1
Engineer and asst. eng	10	....	1	....	11
Contraction work, bridges, canals, drainage, etc.					
Members of company and chief officers	12	....	2	....	14
Dist. engineer and engineer on work	38	....	1	....	39
Asst. and jr. engineer	8	....	....	....	8
Asst. chief engineer	1	....	....	....	1
Superintendent	4	....	....	....	4
Municipal Work					
City engineer or asst. city engineer	12	1	....	....	13
Highway engineer	6	....	....	....	6
Teaching					
Associate professor	2	1	....	....	3
Assistant professor	....	1	....	....	1
Instructor	4	1	2	....	7
Supt. of high school	1	....	....	....	1
Miscellaneous					
Photographer	1	....	....	....	1
Agricultural pursuits	5	....	1	....	6
Banking	2	....	....	....	2
Law	1	....	....	....	1
Medicine	1	....	....	....	1
Fiction writing	....	....	1	....	1
Consulting engineer	1	1	3	....	5
Army engineering	1	....	....	....	1
Insurance	....	....	1	....	1
Draftsmen	16	1	3	....	20
Surveyors	18	....	....	....	18
Advertising	....	....	1	....	1
Chemists	....	....	....	8	8
Dealer in engineering equipment	....	....	1	....	1
State public service commission	1	....	1	....	2
Auditors and accountants	....	....	3	....	3
Inspectors	2	....	3	....	5
Asst. physicist, U. S. Bureau of Standards	....	....	1	....	1
Total of all men heard from	158	27	92	9	286

Library, Hospital, and Incidental Fee. All students in the University except those enrolled in the short winter courses in agriculture, and except those specially exempt by law or by rule of the Curators,* are required to pay a library, hospital and incidental fee of $12 a semester.

Laboratory Deposits. Each student entering a laboratory is required to make a deposit of $5, unless a different amount be fixed by the President and the director of the laboratory. From the amount deposited there is deducted a fixed charge (in no case less than $1, for each individual laboratory course), and also all charges for materials used or for damages to or loss of University property. If the deposit is insufficient to cover all such charges the student is required to make an additional deposit or deposits. When damage or loss is suffered by a laboratory, it is assessed against the deposits of students using the laboratory at time of the damage or loss, unless such damage or loss can be traced to some individual student or students. The remainder of any deposit, after payment of all charges, is refunded to the student at the end of his laboratory course in any session, provided it be called for within twenty days after the close of the session. If not so called for, the amount will be credited to the laboratory in which deposit was made. For details consult the annual catalog.

All fees and deposits must be paid in advance.

Books and Instruments. The cost of books varies considerably depending upon the courses being taken each year; a fair average is from $20 to $30 a year. A good set of drawing instruments is required in the first year's work in mechanical drawing and is used thruout the course. This should cost from $10 to $20, depending upon the quality.

Room Rent and Board. Rooms may be rented in Benton and Lathrop Halls, the University dormitories for men, at from $20 to $35 for each student for a session of 38 weeks. Two students occupy each room and the rent depends upon the location of the room.

For rooms in private houses from $8 to $16 a month is charged, the average being about $12. This is usually shared by two students.

The Commons, run under the direction of the University, consists of a cafeteria in Lathrop Hall. The average cost of meals served in the cafeteria is 13½ cents.

Board in private boarding houses usually costs from $3.50 to $5 a week. Private boarding clubs are formed in which the average cost is about $3 a week.

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*See the annual catalog.

Total Expenses. The table below is intended to give an idea as to the probable yearly expenses of a student in the School of Engineering.

	Low Estimate	Medium Estimate	Very Liberal Estimate
Library, hospital, and incidental fee*..	$24	$24	$24
Room rent	23	50	90
Board	95	133	190
Laboratory deposits	15	20	30
Books	15	25	35
Laundry	18	35	50
Society dues and assessments	2	10	25
Incidentals, amusements, etc.	22	47	100
	$214	$344	$544

Clothing and railroad fares are not included in this table. The actual expenditures will depend largely upon the tastes and inclinations of the individual student. The low estimate in the table is considered to be about the minimum amount required consistent with comfortable quarters and good food. It implies rigid economy in all things. The medium estimate is thought to be about the average amount spent by students in the School of Engineering.

There are many opportunities for a student to earn money to pay part or all of his expenses at Columbia. The Y. M. C. A. conducts an employment bureau to aid students in finding work of this kind. Students who must spend part of their time in outside employment should not expect to take full work in the University and under these circumstances an additional year is often required to satisfy the requirements for graduation. Students coming to Columbia for the first time should not expect to find work at once, but must have some funds available to meet necessary expenses until employment is obtained. This may require several months.

REQUIREMENT FOR ADMISSION

The requirement for admission to the School of Engineering is the same as for admission to the College of Arts and Science, fifteen units, the equivalent of a four-year high school course.

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*Under certain conditions students are exempt from the library, hospital, and incidental fee. For particulars, see the annual catalog.

CURRICULA AND DEGREES

There are four curricula leading respectively to the professional degree of Civil Engineer, Electrical Engineer, Mechanical Engineer and Chemical Engineer. The requirement for a professional degree is 150 credit hours or five years of college work. The work of the first two years is the same in all curricula and will include the following subjects:

English	6 hours
Calculus*	10 hours
Physics	10 hours
Economics	5 hours
Chemistry	5 hours
Drawing	2 hours
Shop	4 hours
Arts electives	18 hours

The other requirements are listed under the various special curricula.

The degree of Bachelor of Science in Engineering may be given at the end of four years of college work for a total of 120 hours credit. This credit must include the required subjects of the first two years as specified above and not less than 45 hours credit selected from the subjects specified for the professional degrees.

Students may obtain both the A. B. and a professional engineering degree in six years. Those who can afford the additional year required are urged to take advantage of the opportunity thus afforded for general cultural training combined with an engineering education. This is made possible by—

(a) The acceptance of the following subjects (to a maximum of 20 credit hours) for the A. B. degree: mechanics (courses 101, 103 and 112); direct current machinery (electrical engineering, course 101a and 102b), 5 hours; elementary alternating currents (electrical engineering, course 110a), 5 hours; heat engines (mechanical engineering, course 135a), 3 hours; descriptive geometry (mechanical drawing, course 9a or b), 2 hours; elementary surveying (civil engineering, course 102a), 3 hours; woodwork (manual arts, course 1a), 2 hours; metal work (manual arts, course 2a), 2 hours; mechanical drawing (manual arts, course 7a), 3 hours.

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*Calculus must be preceded by trigonometry and analytic geometry. This will be counted in the Arts electives.

(b) The waiving of certain restrictions in the choice of electives in the School of Engineering, for students having an A. B. degree.

Students desiring to take both the A. B. and a professional engineering degree should plan their work carefully from the beginning to insure that the following items are accomplished in their first four years:

1. The completion of all the requirements of the A. B. degree (see the annual catalog).

2. The completion of sufficient electives chosen from the subjects from the School of Engineering that are accepted toward an A. B. degree (see list in paragraph (a) above) to reduce the required engineering courses remaining to be taken in the last two years to a maximum of 60 credit hours.

A Class in Design

Curricula meeting all these requirements are not difficult to arrange and considerable latitude may be allowed to satisfy individual needs and inclinations. To assist students in planning their work, a number of suggestive curricula are on file in the office of the dean, School of Engineering.

The courses in engineering require that students be strong in mathematics and science. Those who are not strong in these lines are advised not to undertake work in engineering.

For a full statement of the requirements for entrance, see the annual catalog of the University. This may be secured by addressing the Dean of the University Faculty, University of Missouri, Columbia, Missouri. For special information not found in the catalog, address the Dean of the Faculty of Engineering, University of Missouri, Columbia, Missouri.

CIVIL ENGINEERING

The field covered by this curriculum is wide, embracing topographical, railway, hydraulic, structural, municipal, and highway engineering. It is the aim to give a broad general training which may later serve as a foundation for the development of any special line under the general term, civil engineering.

The curriculum has, therefore, been arranged with the purpose of providing thoro training in those fundamental sciences and principles upon which the practice of the civil engineer is based, and also, in so far as practicable, of giving instruction in the special subjects which underlie the several branches. A number of subjects are made elective, with the object of permitting the student to select his more advanced work in one of the special divisions of civil engineering.

The degree of Civil Engineer is conferred upon the completion of 150 credit hours including the following courses:

General Subject	No. of Course	Special Title	Hours Credit
First two years' work as specified for all	....	....	60
Drawing	8a or b	Machine drawing	2
Drawing	9a or b	Descriptive geometry	2
Civil engineering	102a	Elementary surveying	3
Mechanical engineering	131a	Steam machinery, A.	3
Mechanical engineering	101b	Machine design, A.	3
Electrical engineering	102b	Direct current machinery	5
Mechanics	103	Mechanics of engineering	8
Electrical engineering	103a	Alternating current machinery	3
Civil engineering	132a	Materials of Construction	2
Civil engineering	140a	Hydraulics	3
Civil engineering	120a	Graphic statics	2
Civil engineering	104b	Higher surveying	4
Civil engineering	111a	Railway surveying	4
Civil engineering	121b	Framed structures	3
Civil engineering	125b	Masonry structures	3
Civil engineering	151a	Roads and pavements	2
Civil engineering	152b	Sanitary engineering	2
Geology	2b	Physical geology	3
Civil engineering	141a	Water power	3
Civil engineering	191b	Specifications and contracts	1
		Elective*	29
			150

*All elective work required for graduation must be chosen under the advice of a professor in the department in which the student takes his major work, and subject to the approval of the dean.

ELECTRICAL ENGINEERING

The curriculum in electrical engineering is intended to prepare students for electrical designing, manufacturing, contracting, and for the installation and management of central and isolated electric light stations, power plants and electric railways. It is planned to furnish insight into and appreciation of the complex problems requiring solution by electrical engineers, while giving thoro, broad training.

The technical work consists of the theory and principles of electricity and magnetism; electrical measurements; calibration of instruments; tests of all kinds; design and construction; study of problems in the generation, transmission, distribution, and utilization of electrical energy.

Special attention is paid to alternating current phenomena.

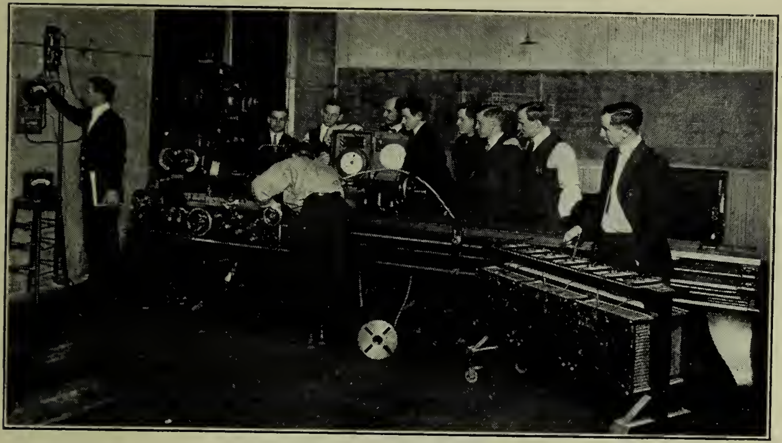
The degree of Electrical Engineer is conferred upon the completion of 150 hours' credit, including the following courses:

General Subject	No. of Course	Special Title	Hours Credit
First two years' work as specified for all..................	....	....	60
Drawing	8a or b	Machine drawing	2
Drawing	9a or b	Descriptive geometry	2
Civil engineering	102a	Elementary surveying	3
Mechanical engineering	131a	Steam machinery, A.	3
Mechanical engineering	101b	Machine design, A.	3
Electrical engineering	102b	Direct current machinery	5
Mechanics	103	Mechanics of engineering	8
Electrical engineering	110a	Alternating current machinery	5
Civil engineering	135a	Materials of construction	2
Civil engineering	140a	Hydraulics	3
Civil engineering	120a	Graphic statics	2
Physics	104b	Electrical measurements	4
Electrical engineering	111b	Advanced alternating currents	5
Electrical engineering	118b	Commercial electrical testing	3
Electrical engineering	120b	Problems in D. C. design	2
Electrical engineering	121a	Problems in A. C. design	2
Electrical engineering	130a	Generation and distribution	4
Civil engineering	191b	Specifications and contracts	1
Electrical engineering	199	Thesis	3
		Elective*	28
			150

*All elective work required for graduation must be chosen under the advice of a professor in the department in which the student takes his major work, and subject to the approval of the dean.

MECHANICAL ENGINEERING

The curriculum in mechanical engineering is intended to fit young men to secure the greatest advantage from the practical experience which must precede, accompany or follow such a study of the applications of the sciences in a profession; and to enable them to be of earlier and greater responsible value in connection with engineering properties—as designers, installing engineers, in testing and inspection



Experimental Lathe

work, in engineering salesmanship or other associated specialties, in power plant operation, in manufacturing, in efficiency improvement, and in the conception, organizing and direction of extended mechanical industrial enterprises.

The degree of Mechanical Engineer is conferred upon the completion of 150 credit hours, including the following courses:

General Subject	No. of Course	Special Title	Hours Credit
First two years' work as specified for all			60
Drawing	8a or b	Machine drawing	2
Drawing	9a or b	Descriptive geometry	2
Civil engineering	102a	Elementary surveying	3
Mechanical engineering	131a	Steam machinery, A.	3
Mechanical engineering	101b	Machine design, A.	3
Electrical engineering	102b	Direct current machinery	5
Mechanics	103	Mechanics of engineering	8
Electrical engineering	103a	Alternating current machinery	3
Mechanical engineering	102a	Materials of manufacture	2
Civil engineering	140a	Hydraulics	3
Civil engineering	120a	Graphic statics	2
Manual arts	2a	Pattern making	2
Manual arts	3	Machine work	4
Mechanical engineering	121	Mechanical laboratory, A.	4
Mechanical engineering	103b	Machine design, B.	3
Mechanical engineering	133b	Steam machinery, B.	3
Mechanical engineering	134a	Steam power plants	4
Civil engineering	146b	Hydraulic motors	2
Civil engineering	191b	Specifications and contracts	1
Mechanical engineering	199	Thesis	3
		Elective*	28
			150

*All elective work required for graduation must be chosen under the advice of a professor in the department in which the student takes his major work, and subject to the approval of the dean.

CHEMICAL ENGINEERING

The rapid development of the chemical industries and the ever increasing demand for engineers trained in the fundamental chemical subjects have led to the introduction of courses in chemical engineering. The curriculum outlined is designed to give a broad and thoro training in general engineering subjects, and in theoretical and applied chemistry. Instruction in chemistry continues thru the whole length of the curriculum. The general principles of physical science are further emphasized by extended courses in mathematics, physics, and mechanics.

The curriculum aims to implant in the students a scientific method of work. Instruction is given by means of recitations, lectures, laboratory work, and conferences. The electives enable the student to give some attention to specialization, but the prime object is to produce a broadly trained chemical engineer.

The degree of Chemical Engineer is conferred upon the completion of 150 hours' credit, including the following courses:

General Subject	No. of Course	Special Title	Hours Credit
First two years' work as specified for all................	....	....	60
Drawing	8a or b	Machine drawing	2
Drawing	9a or b	Descriptive geometry	2
Civil engineering	102a	Elementary surveying	3
Mechanical engineering	131a	Steam machinery, A.	3
Mechanical engineering	101b	Machine design, A.	3
Electrical engineering	102b	Direct current machinery	5
Mechanics	103	Mechanics of engineering	8
Electrical engineering	103a	Alternating current machinery	3
Civil engineering	135a	Materials of construction	2
Civil engineering	140a	Hydraulics	3
Civil engineering	120a	Graphic statics	2
Chemistry	27a or b	Qualitative analysis	5
Chemistry	111	Organic chemistry	6
Chemistry	121	Quantitative analysis	6
Chemistry	131	Physical chemistry	6
Chemistry	141a or b	Industrial chemistry	3
Chemistry	122a	Technical analysis	3
Civil engineering	191b	Specifications and contracts	1
		Thesis	3
		Elective*	21
			150

*All elective work required for graduation must be chosen under the advice of a professor in the department in which the student takes his major work, and subject to the approval of the dean.

STATEMENT OF COURSES

Courses designated by a number with the letter *a* attached, thus: 100a, are given the first semester only. Those designated by a number with the letter *b* attached, thus: 100b, are given the second semester only. Those designated merely by a number are continuous courses and are given both semesters. Courses numbered 200 and above are strictly graduate in character. *Arabic numerals in parenthesis indicate the number of hours credit a semester.* A full description of courses and schedule of days, hours, and rooms will be found in the annual catalog, which may be obtained by addressing the Dean of the University Faculty, University of Missouri, Columbia, Missouri.

CIVIL ENGINEERING

Topographical Engineering

102a or b. **Elementary Surveying** (3) Mr. Williams; Mr. LaRue.
103a. **Farm Surveying and Drainage** (3) Mr. Williams.
104b. **Higher Surveying** (3) Mr. Williams.
105b. **Geodetic Surveying** (3) Mr. Williams.
106a. **City Planning** (2) Mr. Williams.
201. **Geodesy and Precise Surveying** Mr. Williams.

Railway Engineering

111b. **Railway Surveying** (4) Mr. Miller.
112b. **Railway Engineering** (3) Mr. Miller.
114a. **Railway Maintenance** (3) Mr. Miller.
115b. **Railway Yards and Terminals** (2) Mr. Miller.
116b. **Signaling and Interlocking** (2) Mr. Miller.
211. **Railway Engineering** Mr. Miller.

Structural Engineering

120a. **Graphic Statics** (2) Mr. Hyde.
121b. **Framed Structures** (3) Mr. Hyde.
122a. **Structural Design** (4) Mr. Hyde.
123b. **Higher Structures** (3) Mr. Hyde.
124b. **Mill Structures** (2) Mr. Hyde.
125b. **Masonry Structures** (3) Mr. Spalding.
126a. **Concrete Structures** (2) Mr. Spalding.
221. **Bridge Engineering** Mr. Hyde.
222. **Concrete Structures** Mr. Spalding; Mr. Hyde.
223. **Theory of Structures** Mr. Hyde.

Materials of Construction

132a. **Materials of Construction** (2) Mr. LaRue.
133b. **Testing Laboratory** (1) Mr. LaRue.
134b. **Road Materials** (3) Mr. LaRue.
136b. **Cement and Concrete Construction** (2) Mr. Spalding.

Hydraulic Engineering

140a or b. **Hydraulics** (3) Mr. Rodhouse.
141a. **Water Power** (3) Mr. Rodhouse.
142b. **Water Supply** (2) Mr. Rodhouse.
143a. **Irrigation and Drainage** (2) Mr. Rodhouse.
144b. **Rivers and Canals** (2) Mr. Rodhouse.
146b. **Hydraulic Motors** (2) Mr. Rodhouse.
147b. **Hydrology** (2) Mr. Rodhouse.

Municipal Engineering

151a. **Roads and Pavements** (2) Mr. Spalding.
152b. **Sanitary Engineering** (2) Mr. McCaustland.
154a. **Municipal Sanitation** (2) Mr. McCaustland.
155a. **Highway Engineering** (2) Mr. Spalding.
156b. **Highway Design** (2) Mr. Spalding.
157b. **Sanitary Design** (2) Mr. McCaustland.
158b. **Rural Sanitation** (1) Mr. McCaustland.
159a. **Country Roads** (1) Mr. Spalding.
251. **Sanitary Engineering** Mr. McCaustland.

General

191b. **Specifications and Contracts** (1) Mr. Spalding.
199. **Thesis** (1) first semester; (2) second semester.

ELECTRICAL ENGINEERING

101a or b. **Direct Current Machinery** (5) Mr. Weinbach; Mr. Atkinson.
103a. **Alternating Current Machinery** (3) Mr. Atkinson.
110a. **Elementary Alternating Currents** (5) Mr. Kellogg.
111b. **Advanced Alternating Currents** (5) Mr. Kellogg.
118b. **Commercial Electrical Testing** (3) Mr. Weinbach.
120b. **Problems in Direct Current Design** (2) Mr. Gumaer.
121a. **Problems in Alternating Current Design** (2) Mr. Gumaer.
130a. **Generation and Distribution** (4) Mr. Weinbach.
131b. **Electric Motors** (2) Mr. Weinbach.
132a. **Storage Battery Engineering** (2) Mr. Gumaer.

133b. **Illumination** (2) Mr. ATKINSON.
134a. **Telephony** (2) Mr. KELLOGG.
137a. **Switching and Control** (2) Mr. ATKINSON.
140b. **Central Station Practice** (2) Mr. KELLOGG.
141a. **Electric Railway Engineering** (2) Mr. WEINBACH.
142b. **Transmission** (3) Mr. GUMAER.
143a. **Electrical Processes** (2) Mr. WEINBACH.
144. **Central Management and Operation** (3) Mr. WEINBACH.
145a. **Costs in Public Service Enterprises** (3) Mr. KELLOGG.
180a or b. **Application of Mathematics to Electrical Engineering** (2) Mr. GUMAER.
199. **Thesis** (1) first semester; (2) second semester Mr. GUMAER.
214a or b. **Transient Electrical Phenomena** (2) Mr. GUMAER.
230a or b. **High Tension Laboratory** (2) Mr. GUMAER.
231a or b. **Special Electrical Laboratory** (2) Mr. WEINBACH.
240a or b. **Electrical Power Plant Equipment** (2) Mr. KELLOGG.
270a or b. **Advance Telephone Engineering** (2) Mr. KELLOGG.
290. **Research.**

MECHANICAL ENGINEERING

Design

101b. **Machine Design, A** (3) Mr. HIBBARD; Mr. WHARTON.
102a. **Materials of Manufacture** (2) Mr. HIBBARD; Mr. LARUE.
103b. **Machine Design, B.** (3) Mr. FESSENDEN.
104a. **Machine Design, C.** (2) Mr. FESSENDEN.
201a or b. **Special Machine Design.** Mr. HIBBARD; Mr. FESSENDEN.

Shop Management

111b. **Shopwork Engineering, A.** (4) Mr. HIBBARD.
112a. **Scientific Management** (3) Mr. HIBBARD.
113a or b. **Hoisting and Conveying Machinery** (2) Mr. WESTCOTT.
114b. **Engineering Office Work** (1) Mr. HIBBARD.
115b. **Plants and Processes** (2) Mr. FESSENDEN.
211a or b. **Shopwork Engineering, B.** Mr. HIBBARD.

Testing and Experimental Engineering

121. **Mechanical Laboratory, A** (2) Mr. WESTCOTT.
122. **Mechanical Laboratory, B** (2) and (1) Mr. WESTCOTT.
123a. **Mechanical Laboratory, C** (2) Mr. WESTCOTT; Mr. WHARTON.
221a and b. **Special Mechanical Laboratory**

Power Engineering

131a and b. **Steam Machinery, A** (3) Mr. Fessenden; Mr. Westcott.
132a. **Thermodynamics, A** (3) Mr. Wharton.
133b. **Steam Machinery, B** (3) Mr. Fessenden; Mr. Wharton.
134a. **Steam Power Plants** (4) Mr. Hibbard.
135a. **Steam Turbines** (2) Mr. Fessenden.
136b. **Prime Movers** (4) Mr. Westcott; Mr. Wharton.
137b. **Valve Gears** (2) Mr. Fessenden.
139a. **Heat Engines** (3) Mr. Wharton.
231a or b. **Thermodynamics, B.** (2) Mr. Wharton.
232b. **Advanced Steam Turbine Design.** Mr. Fessenden.
234a. **Gas Engines** (2) Mr. Wharton.

Power Applications

151a. **Ventilation and Heating** (2) Mr. Fessenden.
152a or b. **Pumping Machinery** (2) Mr. Wharton.
153b. **Farm Motors** (2) Mr. Wharton.
154b. **Refrigeration, A** (2) Mr. Wharton.
251a. or b. **Refrigeration, B** Mr. Wharton.
252b. **Gas Production** (2) Mr. Wharton.
253a. **Power Transmission** Mr. Hibbard; Mr. Fessenden.

Railway

261a or b. **Railway Shops** (2) Mr. Hibbard.
262a. **Car Design** (2) Mr. Hibbard.
263a or b. **Locomotive Design** (2) Mr. Hibbard.
264b. **Locomotive Operation** (2) Mr. Hibbard.

General

171a or b. **Technical Literature** (1) Mr. Hibbard.
199. **Thesis**
299. **Thesis, Graduate Research**

CHEMISTRY

27a and b. **Qualitative Analysis** (5) Mr. Gibson.
111. **Organic Chemistry** (3) Mr. Calvert.
112a and b. **Preparation of Organic Compounds** (2) or (3) Mr. Calvert.
113a and b. **Preparation of Organic Compounds and Organic Analysis** (3), (4) or (5) Mr. Calvert.
121. **Quantitative Chemical Analysis** (3) Mr. Gibson.
122a. **Technical Analysis** Gas, water, and fuel. (3) Mr. Gibson.
123b. **Technical Analysis** Inorganic commercial products. (3) Mr. Gibson.

125a. **Quantitative Organic Analysis** (3) Mr. Jones.
126b. **Quantitative Organic Analysis** (3) Mr. Calvert.
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142b. **Industrial Chemistry** (2) or (3) Mr. Brown.
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200. **Chemistry of the Rare Earths** (3) Mr. Brown.
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221. **Advanced Quantitative Analysis** Mr. Gibson.
232a and b. **Advanced Physical Chemistry** Mr. Schlundt.
271. **Research**

MECHANICS

101. **Elementary Mechanics** (2) Mr. Defoe.
103. **Mechanics of Engineering** (4) Mr. Defoe.
112. **Advanced Mechanics** Mr. Defoe.
205. **Elasticity** (3) Mr. Defoe.
209. **Hydrodynamics** Mr. Defoe.

MANUAL ARTS

1a or b. **Woodwork** (2) Mr. Griffith; Mr. Abbott.
2a or b. **Metalwork** (2) Mr. Allton; Mr. Abbott.
4. **Machine Work** (2) Mr. Brigham.
133b. **Advanced Molding and Foundry Practice** (2)
134a. **Advanced Pattern Making** (2)
135a. **Advanced Forge Work** (2)
136. **Advanced Machine Work** (2) Mr. Brigham.

MECHANICAL DRAWING

4a and b. **Architectural Drawing** (3) Mr. Welch.
6b. **Advanced Lettering** (1) Mr. Welch.
7a and b. **Mechanical Drawing** (2) Mr. Welch; Mr. Newton.
8a and b. **Machine Drawing** (2) Mr. Welch; Mr. Newton.
9a and b. **Descriptive Geometry** (2) Mr. Welch; Mr. Rodhouse; Mr. Newton.
11a and b. **Perspective** (3) Mr. Rodhouse; Mr. Welch.
140. **Advanced Architectural Drawing** (3) Mr. Welch.
141. **Advanced Machine Drafting** (3) Mr. Newton.

OTHER COURSES

The following courses offered in the College of Arts and Science are of particular interest to students in the School of Engineering:

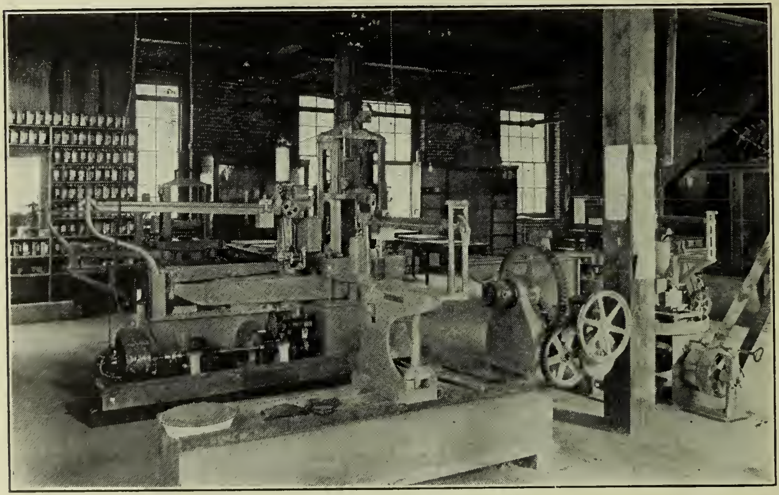
Astronomy. 1a and b, descriptive astronomy; 103a, geodetic astronomy.

Economics. 1a or b, general economics; 110a or b, problems of labor; 117a or b, accounting; 233a or b, valuation of public utilities.

Geology. 2a or b, physical geology; 4b, rocks and rock minerals; 100a, economic geology; 107a, field geology.

Mathematics. 120a and b, differential equations and their applications.

Physics. 104a, electrical measurements; 110b, electricity and magnetism; 207, theory of electricity and magnetism; 112a, heat; 206, theory of heat; 221b, electrical waves.



Materials Testing Laboratory

GRADUATE WORK IN ENGINEERING

Leading to the Degree of Doctor of Philosophy in the Graduate School

Graduates of the School of Engineering holding professional degrees (C. E., M. E., E. E., Ch. E.) will be admitted to candidacy for the degree of Doctor of Philosophy (Ph. D.) in the Graduate School upon the completion of a minimum of two years of additional work.

Graduates of other schools of engineering in good standing who have completed five years of University work will be admitted on the same basis. A minimum of three years of graduate work will be required of all graduates of engineering schools who have completed only four years of university work.

The faculty of the Graduate School reserves the right to pass on the qualifications of all candidates.

The graduate student is expected to devote the major portion of his time to research work. A part of the time may be given to some of the advanced courses offered in engineering, or other university courses allied to the main subject of study.

The work of each candidate is under the supervision of a special committee of the faculty, whose function it is to advise the student in regard to his course of study and the subject of his research.

The usual work consists in the investigation of some engineering problem of practical or scientific importance. In this the student is thrown largely upon his own resources, and must show originality and capacity for accurate scientific thinking. The results of the researches are to be embodied in a dissertation which shall give evidence of the merit of the work and the ability of the student. The regulations governing the degree of Doctor of Philosophy are given in the annual catalog.

The equipment and funds of the Engineering Experiment Station are available for experimental research, provided the subjects being investigated are of such practical importance as to conform to the general purpose for which the experiment station was established.

A limited number of research assistants in the engineering experiment station are appointed each year, and under suitable conditions work carried on by these assistants may count toward the doctor's degree. This makes the research assistantship equivalent to a graduate fellowship, enabling the candidate thus appointed to work toward his degree and at the same time earn his expenses during a part of the time.

For further information regarding graduate work, address DEAN OF THE GRADUATE FACULTY, UNIVERSITY OF MISSOURI, COLUMBIA, MISSOURI.

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Research Assistant, Engineering Experiment Station.

THE ENGINEERING EXPERIMENT STATION

OFFICERS OF THE STATION

ALBERT ROSS HILL, Ph. D., LL. D., *President of the University.*

ELMER JAMES McCAUSTLAND, C. E., M. C. E., *Dean of the Faculty of Engineering, Director of the Engineering Experiment Station.*

The Engineering Experiment Station of the University of Missouri was established by order of the Board of Curators, July 1, 1909.

The object of the station is to be of service to the people of the State of Missouri:

First: by investigating such problems in engineering lines as appear to be of the most direct and immediate benefit and publishing these studies and information in the form of bulletins.

Second: by research of importance to the manufacturing and industrial interests of the state and to engineers.

The staff of the station consists at present of a director and four research assistants together with a number of teachers who have undertaken research under the direction of the station.

Suggestions as to problems to be investigated, and inquiries will be welcomed.

Bulletins have been published as follows:

Vol. 1, No. 1, *Acetylene for Lighting Country Homes*, by J. D. Bowles, research assistant, 1909-10.

Vol. 1, No. 2, *Water Supply for Country Homes*, by K. A. McVey, research assistant, 1909-10.

Vol. 1, No. 3, *Sanitation and Sewage Disposal for Country Homes*, by W. C. Davidson.

Vol. 2, No. 1, *The Heating Value and Proximate Analysis of Missouri Coals*, by C. W. Marx and Paul Schweitzer. (A reprint.)

Vol. 2, No. 2, *Friction and Lubrication Testing Apparatus*, by Alan E. Flowers.

Vol. 2, No. 3, *Tests of Road Materials of Missouri*, by W. S. Williams and Warren Roberts.

Vol. 3, No. 1, *The Use of Metal Conductors to Protect Buildings from Lightning*, by E. W. Kellogg.

Vol. 3, No. 2, *Firing Tests on Missouri Coal*, by H. N. Sharp, research assistant, 1911-12.

Vol. 3, No. 3, *A Report on Steam Boiler Trials Under Operating Conditions*, by A. L. Westcott.

Vol. 4, No. 1, *Economics of Rural Distribution of Electric Power*, by L. E. Hildebrand, research assistant, 1912-13.

Vol. 4, No. 2, *Comparative Tests of Cylinder Oils*, by M. P. Weinbach.

Vol. 4, No. 3, *Artesian Waters of Missouri*, by A. W. McCoy, research assistant, 1912-13.

Vol. 4, No. 4, *Friction Tests on Lubricating Grease and Oils*, by A. L. Westcott.

Engineering Experiment Station Series 14, *A Study of the Effect of Heat on Missouri Granites*, by W. A. Tarr and L. M. Neuman, research assistant, 1913-14.

Engineering Experiment Station Series 15, *A Preliminary Study Relating to the Water Resources of Missouri*, by T. J. Rodhouse.

The following studies are now in progress:

Coal testing
Deep wells and deep well pumping
Fire and accident prevention
Artificial illumination
Economics of electric cooking
Transmission of heat through boiler surface
Effect of size and quality of sand upon cement mortar
Missouri clays
Water power in Missouri
Metallic alloys

besides a number of detailed studies of materials and processes and investigations of Missouri's natural resources.

A standardizing laboratory has been established and part of the apparatus is now available.

Any resident of the state may, on request, obtain bulletins as issued, or if particularly interested, may be placed on the regular mailing list. Address DIRECTOR, ENGINEERING EXPERIMENT STATION, UNIVERSITY OF MISSOURI, COLUMBIA, MISSOURI.

INFORMATION ABOUT THE UNIVERSITY

The fundamental aim of the University of Missouri is the development of the highest and most efficient type of citizen. For the purpose of attaining its aim, the University furnishes ample facilities for liberal education and for thoro professional training. The University is a part of the public educational system of the state.

ORGANIZATION

The work of the University is now carried on in the following divisions:

College of Arts and Science
College of Agriculture
School of Education
School of Law
School of Medicine
School of Engineering
School of Mines and Metallurgy
School of Journalism
School of Commerce
Graduate School
Extension Division

All of these divisions are at Columbia, with the exception of the School of Mines and Metallurgy, which is located at Rolla. In addition, emphasis is given particular lines of work by the establishment of minor divisions, the chief of which are the Agricultural Experiment Station, the Engineering Experiment Station, and the Missouri State Military School.

LOCATION

The University of Missouri is located at Columbia, situated half way between St. Louis and Kansas City, near the center of the state. It is reached by the Wabash and by the Missouri, Kansas and Texas railways. Columbia is a progressive and prosperous town having doubled its population in the last few years.

Columbia may be characterized as a town of schools, homes, and churches, with enough of industrialism to make it efficient. It offers the conveniences of a larger city without the counter attractions. The student is a predominant factor in Columbia.

EQUIPMENT

The University grounds cover more than 800 acres. The main divisions are in the west campus, the east campus, the athletic fields, and the University farm.

The following University buildings are located at Columbia: Academic Hall; Laws Observatory; separate buildings for chemistry, physics, biology, commerce and geology, engineering, manual arts, law; two power houses; Library Building; Medical Laboratory Building; Parker Memorial Hospital; Agricultural Building; Horticultural Building; Schweitzer Hall for agricultural chemistry; green houses; Live Stock Judging, Poultry, Dairy, Farm Machinery, and Veterinary Buildings; the University farm barns and buildings; Switzler Hall for the School of Journalism; Gordon Hotel Building for home economics; Benton and Lathrop Halls, dormitories for men; Read Hall and Sampson Hall, dormitories for women; Rothwell Gymnasism; the houses for the President of the University and the Dean of the Faculty of Agriculture; the High School and the Elementary School buildings, used for practice schools in the School of Education. The new library building will be occupied in the course of the summer of 1915.

FOR FURTHER INFORMATION

For further information concerning the School of Engineering, address

E. J. McCaustland,
Dean, Faculty of Engineering,
University of Missouri,
Columbia, Missouri.

Full information regarding the University is given in the catalog, which will be sent on request without charge. For this or special bulletins of the College of Arts and Science, College of Agriculture, School of Education, School of Law, School of Medicine, School of Engineering, School of Journalism, School of Commerce, Extension Division, and the Graduate School, write to

Dean of the University Faculty,
University of Missouri,
Columbia, Missouri.

THE
UNIVERSITY OF MISSOURI
BULLETIN

GENERAL SERIES

EDITED BY
HUGH J. MacKAY
University Publisher

The General Series of The University of Missouri Bulletin consists of the announcements of the various colleges and schools which make up the University. These announcements will be sent free upon request to the Dean of the University Faculty, Columbia, Missouri.

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ANNOUNCEMENT
OF THE
SCHOOL OF ENGINEERING
1916-1917

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COLUMBIA, MISSOURI
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The Modern Engineer

In 1828 the Institution of Civil Engineers was organized in London. In the charter of the Institution, civil engineering was defined as the "art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states, both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation and docks for internal intercourse and exchange, and in the construction of harbors, moles, breakwaters and light houses, and in the art of navigation by artificial power for the purpose of commerce, and in the construction and adoption of machinery, and in the drainage of cities and towns."

For many years this definition has been a classic, regarded as expressing a definite view of the field covered by engineering practice. Many changes have occurred since the organization of the great Institution, and the enumeration of lines of work might be considerably modified and extended if it were to be written at the present time. To prepare a complete statement of what constitutes the entire field of engineering would be a large task, and it is only proposed here to give some brief account of the various fields of activity in which engineers may be engaged, and of the demands of practice upon the modern engineer.

HISTORICAL SKETCH

Previous to the middle of the eighteenth century, engineering was applied almost exclusively to the purposes of war. In a few instances civil public works were constructed, but usually the engineers were military officers and the works executed by soldiers. About this period, however, a new class of engineers appeared, who concerned themselves with works of much the same character, but not military in purpose and not executed by soldiers. These men were known as "civil engineers" to distinguish them from the "military engineers." The increase in urban population and development of trade made a demand for public works, and for machinery, which soon caused the importance of the new profession to be recognized, and the number of its members to rapidly increase.

During the early period there was no division of the field of engineering into specialties. Civil engineers covered the whole range of works included in the definition. Among these early engineers were a number of very able men, who with but little training in the laws of science, and without precedents of practice to guide them, succeeded in accomplishing difficult engineering feats, and in establishing a safe and rational practice.

About the middle of the nineteenth century the industrial development which followed the invention of the steam engine had so widened the field of engineering practice, and so increased the demands upon the engineering profession, that a single engineer could no longer cover the whole range of practice, and engineers began to devote their attention to more restricted lines of work. This resulted in dividing engineers into classes, each devoting its attention to a special field.

DIVISION INTO SPECIALTIES

The demand for motor power and machinery for industrial enterprises and transportation caused many engineers to devote themselves exclusively to such work. These men were called "mechanical engineers" and soon were recognized as a distinct branch of the profession. The term civil engineer was still applied to those not primarly concerned with the production or operation of machinery.

Almost immediately following the establishment of mechanical engineers into an independent profession, mining engineering became a separate branch. The demand for metals and coal consequent upon the industrial development already mentioned caused many engineers to devote their whole attention to the opening and operation of mines. These were called "mining engineers."

Near the close of the nineteenth century the discovery of methods of applying electricity to numerous uses and the consequent immense development of electrical plants and appliances caused many men to devote their attention primarily to electrical work. These men were recognized as a distinct branch of the profession and called "electrical engineers."

Recently the development of chemical industries has created a demand for men who give their attention primarily to the construction and operation of plants for manufactures in which chemical processes play a leading part. These men are called "chemical engineers."

At present these five divisions of engineering practice are commonly recognized as distinct professions, or as distinct branches of the engineering profession. Schools of engineering commonly give separate curricula leading to degrees in each of these divisions, and while much of the training necessary to make an engineer is common to several or all of them, each engineer is usually recognized as belonging in one division, and limits his practice to his special branch.

The field of engineering practice is constantly widening. Great changes have taken place during the last few years in the standards of living of the people; urban populations have grown rapidly; manufacturing industries have greatly increased in number and become more diversified. The result of all this has been to make larger demands for the services of the engineer and to enlarge the scope of his activities. This growth has naturally caused a further subdivision of the various branches of engineering practice into narrower specialties, not usually recognized as separate professions, but each offering a sufficient opportunity for the exercise of the best endeavors of the men who follow them.

CIVIL ENGINEERING

The term civil engineering is still often used in its original sense as covering all engineering not military, but commonly it is limited to those fields of practice not included in the other branches.

In the number of special fields of work included, it is much the broadest branch of engineering practice. It comprises:

Surveying, which in simple forms is used by all civil engineers, but which when applied in geodetic and topographic work may constitute a distinct field of practice.

Hydraulic engineering, which includes the design and construction of harbors and docks; river improvements, canals, irrigation works, drainage and flood prevention, and water power projects.

Sanitary engineering, covering all works designed to protect the public health, such as water supply and water purification, sewerage and sewage disposal, and the disposal of garbage and refuse.

Highway engineering, in which may be included both the maintenance and improvement of country roads and the construction and maintenance of city streets and pavements.

Railway engineering, which deals with the design, construction and maintenance of all works required for steam and electric railways.

Structural engineering, which is concerned with the design and construction of bridges and of the structural features of large buildings that carry heavy loads; masonry and concrete structures, and heavy foundations.

General construction, under which head may be included the execution of large works of construction, and the transportation and handling of heavy materials.

MECHANICAL ENGINEERING

The term mechanical engineering is usually employed to designate the work of those engineers who have to do primarily with steam or other engines, machine tools, mill work and moving machinery in general. The lines of work included in the practice of a mechanical engineer may be:

Power engineering, which consists in the design, construction, and operation of machines and plants for the generation of power. These may include steam, gas, oil, or other engines, with all the auxiliary appliances necessary to their operation, as well as the various methods of power distribution.

Design of plants and machinery for the utilization of power, requiring the study of special processes for which machinery may be required, and the adaptation of machines and arrangement of plants for purposes of economical production.

Shop management, dealing with the control and management of shops in the operation of manufacturing plants.

Gas engineering, covering the production, distribution, and utilization of gas for light, heat and power purposes.

Railway mechanical engineering, consisting of the design, construction, and operation of rolling stock and other machinery, and of the shops required in the operation of railways.

ELECTRICAL ENGINEERING

Engineers who are concerned mainly with the generation, transmission, or utilization of electrical energy are known as electrical engineers.

The last few years have seen a very great increase in the applications of electricity and the field of its usefulness is constantly widening. The special fields of most importance into which electrical engineering is divided are:

The design and construction of generators, motors and other apparatus required in the generation, distribution and utilization of electric power.

The design, construction and operation of plants for generating electric power and lines for its transmission.

The application of electricity to industrial power.

The building and operation of electric railways.

The utilization of electric energy for lighting purposes.

The design, construction and operation of telephone and telegraph systems.

The application of electricity in the various chemical industries.

CHEMICAL ENGINEERING

Engineers with special training in chemistry, who devote themselves to the development of the various chemical industries, are known as chemical engineers. Much of recent progress is due to the discovery and development of new materials and compounds with characteristics that make them valuable in the arts. A great part of the research being carried on for commercial purposes lies along these lines. A man who has had a thoro training in chemistry, and who combines with his knowledge of chemistry an insight into physical and mechanical problems and an appreciation of the commercial significance of his work, is best qualified to make himself valuable in investigation of this kind. Not only the discovery of new products, but the maintenance of a standard of quality in manufactured materials, demands the labor of men who have a knowledge of chemistry. This field of work is rapidly becoming very large because of the many and varied industries which have been and are being developed.

RELATION OF ENGINEERS TO SOCIETY

Attention has already been called to the great changes which have taken place in the status of the engineering profession in consequence of the development of industries and the altered standards of living during the past century. These improved social conditions are, for the most part, the result of the work of the engineer. The discoveries of modern science as applied in engineering practice have worked miracles for the better health, comfort, and convenience of modern life.

The invention and perfection of the steam engine was followed by the development of the factory system, making possible the supply of all kinds of manufactured articles at low cost. Then came the steamboat and railroads as methods of transportation, gas for illumination, and the telegraph for quick communication, later all the various electric appliances, and, in our cities, water supply, paving, and sewage disposal. These developments have changed the whole aspect of life, both in city and country, and have made the engineer absolutely essential to modern progress.

In view of the enormously important part which the engineer plays in the life of today, it is very necessary that he should be well trained and fully prepared to meet the responsibilities which rest upon him. In a state possessing immense natural resources, capable of development to a position of great wealth and power, and of providing occupation and homes for a large population, it is highly important that there be found a body of engineers able to direct this development in the best way, that resources may be conserved, and improvements economically made. It is also important that the youth of the state have opportunity to make the best of themselves in whatever field of endeavor may be most attractive to them. It is therefore the duty of the School of Engineering to provide a thoro and adequate training for the young men who seek to be engineers, and to maintain a high standard of admission to the profession.

OPPORTUNITIES FOR ENGINEERS

There are good opportunities in engineering practice for able and well trained men. Success in engineering depends upon close application and wide experience. It is a strenuous occupation and holds forth no inducements to the man who is looking for an easy way to make a living. During the last few years entrance into engineering work has been easy for the man who has shown energy and ability as a student. After entrance into practice, the future of the engineer depends upon himself. There is opportunity of advancement for the man whose training has developed capacity for work, and who has interest in his work. The financial rewards are not great usually, although the more successful men have little cause for complaint. The true engineer has enthusiasm for his work. Opportunity for service is more to him than personal gain.

The largest field for engineering practice is in the service of various corporations. A few engineers, after obtaining considerable experience, are able to practice as independent consulting engineers, or as designing engineers for special lines of work. Many leave the technical side of engineering work and take up administrative positions, or become connected with the business side of industrial enterprises. Remuneration is commonly greater in such work than in the purely technical work of engineering design.

The rapid growth of public interest in the affairs of corporations controlling public utilities emphasizes a field of work which is peculiarly suitable for engineers. In this and many other states, public service commissions have been established having much power in the regulation of the business of public service corporations. For example, they may fix rates and enforce standards of quality, quantity and service; they may authorize bond issues or forbid them, depending upon the financial condition of the corporation. In the exercise of these and other functions, the commissions need the services of well trained engineers as do also the corporations affected by the commissions. To be fitted for work of this nature, the engineer must not only be well equipped with technical knowledge but must also thoroly understand and appreciate the legal, economic, commercial, social, and ethical questions involved in problems of valuation, and rate fixing.

Another field of activity for engineers is suggested in the increasing tendency of municipalities to own and operate their electric light and power, water and gas plants. Heretofore the work of the municipal engineer has been largely confined to planning and overseeing the construction and maintenance of streets and pavements, sewers, parks, water mains. The training necessary to qualify for work of this kind has been best supplied by the curricula in civil engineering. For municipalities owning and operating their public utilities the office of city engineer may be well filled by a mechanical or electrical engineer who has included in his technical training, the proper courses covering surveying, streets, pavements, sanitation, sewers, water supply. A student following the regular civil engineering curriculum may prepare for the same field of usefulness by completing courses concerning the principles of steam and electrical machinery and power plants, pumping machinery, lighting and water systems.

THE TRAINING OF ENGINEERS

The education and training of most of the best modern engineers is accomplished by a course of study in a technical school, followed by experience in actual practice. Both are necessary to produce the well equipped engineer. The technical school gives a training in the sciences, and to some extent in the arts which underlie engineering practice. The object should be to develop power in the student to deal with problems involving mathematical and physical sciences, and to cultivate the faculty of independent thought in dealing with such problems.

The fields covered by civil, electrical, mechanical and chemical engineering are so broad and so varied in character that at first it may not be apparent that they possess points in common which cause them to be grouped under a single classification and called engineering. Some of the considerations which are involved in work that is distinctively engineering in character are:

The work must be essentially useful, and those bearing the responsibility must be convinced of its success and utility before it is undertaken.

It has to deal, at some point, with the forces of nature so that the problems involved demand a knowledge of natural laws for their solution. But while some physical, chemical or mechanical problem is always present it is very often necessary to deal with psychological, economic or social factors as well.

Commercial or economic considerations are the determining factors in nearly every engineering problem.

These are some of the features in the problems themselves that make them essentially engineering problems. Engineering has also its characteristic methods, and while these methods may be used by others the engineer is especially at home with them. They involve:

The collection, classification and analysis of data bearing on the problem in hand.

The use of graphical representations of physical laws and characteristics.

The application of known physical laws to the design of apparatus and to the prediction of the action of the thing designed.

Conservatism to insure the building of things for safety and reliability.

The basing of decisions on sound financial policy and ultimate long term economy.

The review of the result and the tempering of the decision in the light of judgment and experience.

These methods of handling problems are sufficiently well defined and systematic to make experience and training along one line valuable in almost any other kind of work. The man who has had good engineering training is exceptionally well fitted to meet and solve problems in any sphere of activity.

The demands of modern engineering practice are for men of broad training. The man who is trained only in the technical side, however thoro may be his acquaintance with the sciences and however skillful he may be in working out the technical features of a design, can not achieve the highest success in his profession. Executive and administrative positions carrying the most responsibility and earning the highest remuneration are frequently best filled by men having engineering training. The duties pertaining to positions of this character are usually more concerned with the commercial rather than the purely technical side of engineering and the qualities which go farthest toward making success are business sense and the ability to deal with people. These qualities are most likely to occur in men whose viewpoint is broad and who can understand and sympathize with the motives and interests of others.

The idea is too prevalent among young men preparing themselves for the practice of engineering that nothing is of importance in such preparation which does not directly concern the technical features of their work and they are even inclined at times to look with disdain upon work in other branches of engineering than their own.

This tendency is usually more marked among those in the earlier stages of preparation than later, when the student has reached a point where he begins to realize something of the real character of the work upon which he is about to enter. It is, therefore, important that those entering upon a course of training in preparation for professional work should be made to realize that breadth of training is necessary. The man who devotes himself exclusively to the technical work of his profession, may become highly skilled in such work. He may be a valuable man in the work with which he is familiar and highly appreciated for his technical skill by the broader man who is chief over him, but he will not be a chief himself. Men develop capacity for directing large affairs by acquiring intimate knowledge of their fellow men and learning how to deal with them. The training and experience of an engineer should give him capacity to direct large business projects, requiring judgment in matters pertaining to engineering. They should make him the logical man to control such enterprises. In order to be fitted for this work, a man must not only be expert in the technical details of the work, but he must have such knowledge of history and such an acquaintance with social and economic laws as to enable him to appreciate the relations of his work to the world about him.

He must, moreover, be able to formulate his ideas concisely and intelligibly, and to present them to others in an agreeable and convincing manner.

These matters should be seriously considered by the young man about to embark on a course of training which is to fit him for the practice of engineering, as well as by those having the direction of students looking forward to such practice.

PRELIMINARY AND TECHNICAL TRAINING

When the student enters the School of Engineering, he spends about two years in the study of arts and science subjects, after which his attention must necessarily be given mainly to the technical courses required for his professional training. These later courses include instruction in the principles of the sciences which underlie engineering practice, and in the applications of these sciences to engineering problems, as well as in the methods employed by engineers in actual practice.

Several methods of instruction are employed depending in each instance upon the character of the work and the purpose with which it is given. Lectures, recitations, and quizzes are used for the purpose of giving a connected development of methods of practice in a given field. Problems in computation and design are employed to show the ways in which scientific principles are applied to engineering problems, to illustrate methods used in practice, and to develop the ability of the student to apply his scientific knowledge to questions arising in engineering design. Laboratory instruction is freely used to illustrate principles outlined in lecture courses, to familiarize the student with the construction and operation of machines or with the behavior of materials, and to develop capacity for independent investigation.

Efficient preparation for practice in any of the branches of engineering requires a broad training in the fundamental applications of science which underlie such practice, as well as some knowledge of the principles and methods of practice in the other fields of engineering. Narrow specialization is never allowable in undergraduate work. Engineering curricula, therefore, are made up mainly of required courses necessary to this fundamental training, but a certain amount of time is usually available for elective work in which a student may study more fully in one of the special lines of practice, or in which he may obtain a wider knowledge of fields of practice outside his own. The way in which elective time may be utilized to the best advantage varies with the preparation of the student and the purpose he has in view. The object should always be to secure symmetrical training, carrying preparation for the special field of practice as far as may be possible without sacrificing breadth of foundation.

The School of Engineering

Instruction in engineering at the University of Missouri began with the establishment of a Chair of Civil Engineering in the College of Agriculture and Mechanic Arts, with a curriculum leading to the degree of Civil Engineer. Later, as the demand grew for technically trained men in the more restricted branches, instruction was offered in mechanical and in electrical engineering. In 1907, the engineering departments were separated from the College of Agriculture, and organized as an independent division of the University, known as the School of Engineering. This school now offers four curricula covering a period of five years each leading to the respective degrees of

Civil Engineer
Electrical Engineer
Mechanical Engineer
Chemical Engineer

The object of the several curricula is to provide a broad, thorough and systematic training in the fundamental applications of the sciences which underlie the work of the engineering profession in its different branches, together with some opportunity for specialization by the proper selection of elective courses.

Provision is also made for the conferring of a Bachelor's degree upon the completion of four years of work or a total of 120 hours. See page —.

BUILDINGS AND EQUIPMENT

The departments of electrical and mechanical engineering occupy the main Engineering Building and the department of civil engineering occupies Switzler Hall. The work in chemistry required of students in chemical engineering is given in the Chemistry Building.

The main engineering laboratories are in the Engineering Annex in the rear of the Engineering Building. A substantial addition to the Engineering Annex is now being used for the expansion of the mechanical engineering laboratory and for the development of a hydraulic laboratory. Shop work is conducted in a building recently erected for the purpose.

Civil Engineering. The laboratory for testing materials is in charge of the department of civil engineering. The equipment includes several vertical testing machines with all the necessary accessories for tension, compression and transverse tests on the ordinary engineering materials, iron, steel, cement, concrete, brick; a beam-testing machine;

a torsion machine; impact and abrasion machines. There is also a complete equipment for all the standard tests upon hydraulic cement.

The road materials laboratory contains the necessary machines for making complete tests upon stone for road purposes, a standard rattler for paving brick tests, and the apparatus required in investigating bituminous road materials.

There is a good collection of surveying instruments, including the instruments used in ordinary field practice and those necessary for precise surveying and geodetic work.

Stream gages, with a dam and weirs on streams near Columbia, afford opportunity for field study of water supply problems, while practice in hydrographic surveying and stream measurement is obtained by a trip to a river in the neighborhood.

Hydraulic Laboratory. A new hydraulic laboratory has been equipped recently for the study of problems where large quantities of flowing water are needed. Two large size direct-connected electric motor-driven centrifugal pumps have been installed. These pumps will supply water for investigations relating to the flow of water in flumes, large pipes and conduits; to the discharge over dams and weirs, thru racks, sluices, and submerged orifices; and to other features encountered in water power and water supply developments.

Apparatus for the study of the flow of water thru pipes, fire hose and nozzles, and the effect of valves and bends; for the study of the flow of water thru sand filters, and of ground-water flow in soil drainage; and for the testing of pumping machinery and water wheels.

Full equipment for the accurate measurement of quantities, velocities, and pressures, both in open and closed channels is available, and includes the latest types of Pitot tubes, automatic self-recording gages and water meters.

Mechanical Engineering. The mechanical engineering laboratory contains several different types of steam engines, a small steam turbine with a superheater, condensers, gas engines, reciprocating and centrifugal pumps, a number of fans, blowers, and heating coils for work on ventilation and heating, and a variety of other machinery. Much attention is paid to the study of fuels of all kinds. Complete standard apparatus for determining the analysis and calorific value of coals and gases is provided. The laboratory is supplied with the usual equipment of indicators, gages, water and gas meters, scales, and other necessary accessories.

The central power plant of the University is used for conducting boiler tests under actual operating conditions. Considerable attention is given to the study of refrigeration. Several small ice and cold storage plants belonging to the University are available for tests. A local privately owned plant is also sometimes used.

A high-grade lathe, completely equipped for use in connection with courses in shop efficiency, has been purchased recently. It will be used to make production tests to determine the proper kinds of tools and the best cutting speeds to use in making machine parts.

Electrical Engineering. The electrical engineering laboratory contains direct and alternating current generators and motors of the common types met with in practice, and all the instruments necessary to make complete tests of their operation. Besides several low ratio transformers used in routine exercises, the laboratory has a 10,000 volt transformer for testing dielectric strengths and one of 40,000 volts for high tension experiments. A set of Edison cells and one of chloride cells are available for experiments on storage batteries.

A low voltage motor-generator set is provided for general electrochemical processes, such as electro-plating with gold, silver, nickel, and copper. One large and several small electric furnaces are used for demonstrations of the electric processes involved in the production of carborundum, graphite, emery, calcium carbide, ferro-alloys.

The telephone equipment comprises a demonstration board showing all the apparatus and operations involved in a connection through two offices. For experiments in telephone transmission there is a high frequency generator and an artificial line which is electrically equivalent to fifty miles of underground wire.

The laboratory also has a quadruplex telegraph set.

Chemical Engineering. In addition to the laboratories in general chemistry, there are separate laboratories for the other fundamental courses in chemistry required in the chemical engineering curriculum. The general analytical laboratory offers facilities for work in qualitative and quantitative analysis. Special work in the technical analysis of fuels, water, gas, and commercial products is given in smaller laboratories equipped especially for these lines of work. Two laboratories are available for general work in organic chemistry, and more advanced work along organic lines is provided for in a furnace room and a laboratory for the preparation of organic compounds. The laboratory in physical chemistry is equipped for work in electro-chemistry and measurements in radio-activity. Advanced students have an opportunity to pursue work in metallography. The electrical laboratories in the Engineering Building offer facilities for work in electroplating, storage battery engineering, and electrical processes.

Library. The engineering library in the Engineering Building has 5,000 standard engineering books. These have been very carefully selected and include the works of all of the best American and English engineering authors. About 100 periodicals are regularly received, together with publications recording the transactions of the more important engineering societies.

Engineering students are permitted free access to the library shelves for reference and are encouraged to draw books for outside reading.

The general library of the University and the library of the State Historical Society together containing about 200,000 books and pamphlets are open to all students in the University.

STUDENT ACTIVITIES

Notwithstanding a very strong *esprit de corps* among the students of the School of Engineering, they are keenly interested in all of the activities of the general student body and the enterprises common to student life.

ENGINEERING SOCIETIES

Branches of two national engineering societies, the American Institute of Electrical Engineers and the American Society of Mechanical Engineers have been established for several years. Meetings of each are held semi-monthly for the discussion of current engineering problems, usually drawn from the publications of the national societies received regularly by the members of the branches. Practically all of the upperclassmen in electrical engineering and mechanical engineering are active members of one or the other of the branches and a great deal of interest is taken in the meetings. These societies are strongly encouraged because of the benefits to be derived from practice in preparing and delivering papers before a critical audience and for the acquaintance with the activities of the prominent engineers composing the national societies.

During 1913, the Civil Engineers' Society, working along lines similar to those followed by the branches discussed above, was organized. This society is not affiliated with a national society, however.

ATHLETICS

Students in all divisions of the University are encouraged to take part in athletics in one form or another. Class teams and Varsity teams are maintained in football, baseball, basketball, tennis, track work. These are all very carefully supervised and under the direction of the experienced coaches and trainers.

Rothwell Gymnasium is a stone building only a few years old. The gymnasium room is well lighted and well ventilated and equipped with the usual apparatus. Bathing, locker, and dressing facilities are provided in the basement. During good weather much of the systematic work is carried on in an outdoor gymnasium arranged near Rothwell Gymnasium.

"Rollins Field," named in recognition of the generosity of members of the Rollins family, is just west of Rothwell Gymnasium. It contains a quarter-mile cinder track, a 220-yard straight away, grounds for field athletics, a gridiron for football, and a baseball field. All intercollegiate contests are held here.

Concrete bleachers which seat 4,250 persons have been constructed. A new concrete fence with ornamental gate partially surrounds Rollins Field.

Tennis courts, basketball courts, baseball, football, and soccer fields for all students are situated near the gymnasium.

A nine-hole golf course is open to the faculty and all students.

EMPLOYMENT BUREAU

The School of Engineering has always made an effort to secure employment for its graduates.

Inquiries for men to fill advanced positions requiring more or less special experience are occasionally received. A file showing the records of graduates as they are received from time to time on blanks sent them for the purpose, often makes it possible to recommend men particularly fitted for these positions.

FEES AND EXPENSES

Tuition. Tuition is free in all divisions of the University to students who are residents of the state. Non-residents of the state are required to pay a tuition fee of $10 a semester in all divisions of the University, except in the Graduate School.

Library, Hospital, and Incidental Fee. All students in the University except those enrolled in the short winter courses in agriculture, and except those specially exempt by law or by rule of the Curators,* are required to pay a library, hospital and incidental fee of $12 a semester.

Laboratory Deposits. Each student entering a laboratory is required to make a deposit of $5, unless a different amount be fixed by the President and the director of the laboratory. From the amount deposited there is deducted a fixed charge (in no case less than $1, for each individual laboratory course), and also all charges for materials used or for damages to or loss of University property. If the deposit is insufficient to cover all such charges the student is required to make an additional deposit or deposits. When damage or loss is suffered by a laboratory, it is assessed against the deposits of students using the laboratory at time of the damage or loss, unless such damage or loss can be traced to some individual student or students. The remainder of any deposit, after payment of all charges, is refunded to the student at the end of his laboratory course in any session, provided it be called for within twenty days after the close of the session. If not so called for, the amount will be credited to the laboratory in which deposit was made. For details consult the annual catalog.

All fees and deposits must be paid in advance.

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*See the annual catalog.

Books and Instruments. The cost of books varies considerably depending upon the courses being taken each year; a fair average is from $20 to $30 a year. A good set of drawing instruments is required in the first year's work in mechanical drawing and is used thruout the course. This should cost from $10 to $20, depending upon the quality.

Room Rent and Board. Rooms may be rented in Benton and Lathrop Halls, the University dormitories for men, at from $20 to $35 for each student for a session of 38 weeks. Two students occupy each room and the rent depends upon the location of the room.

For rooms in private houses from $8 to $16 a month is charged, the average being about $12. This is usually shared by two students.

The Commons, run under the direction of the University, consists of a cafeteria in Lathrop Hall. The average cost of meals served in the cafeteria is 14½ cents.

Board in private boarding houses usually costs from $3.50 to $5 a week. Private boarding clubs are formed in which the average cost is about $3 a week.

Total Expenses. The table below is intended to give an idea as to the probable yearly expenses of a student in the school of Engineering.

	Low Estimate	Medium Estimate	Very Liberal Estimate
Library, hospital, and incidental fee*..	$24	$24	$24
Room rent	23	50	90
Board	95	133	190
Laboratory deposits	15	20	30
Books	15	25	35
Laundry	18	35	50
Society dues and assessments	2	10	25
Incidentals, amusements, etc	22	47	100
	$214	$344	$544

Clothing and railroad fares are not included in this table. The actual expenditures will depend largely upon the tastes and inclinations of the individual student. The low estimate in the table is considered to be about the minimum amount required consistent with comfortable quarters and good food. It implies rigid economy in all things. The medium estimate is thought to be about the average amount spent by students in the School of Engineering.

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*Under certain conditions students are exempt from the library, hospital, and incidental fee. For particulars, see the annual catalog.

There are many opportunities for a student to earn money to pay part or all of his expenses at Columbia. The University conducts an employment bureau to aid students in finding work of this kind. Students who must spend part of their time in outside employment should not expect to take full work in the University and under these circumstances an additional year is often required to satisfy the requirements for graduation. Students coming to Columbia for the first time should not expect to find work at once, but must have some funds available to meet necessary expenses until employment is obtained. This may require several months. Information regarding employment may be had by addressing, Secretary, Employment Bureau, Y. M. C. A. Building, Columbia, Mo.

REQUIREMENT FOR ADMISSION

Fifteen units, the equivalent of a four-year high school course, are required for admission as a regular student in the School of Engineering. Three units in English, one unit in mathematics and two units in one foreign language are fixed requirements. The remaining nine units may be selected from the list given in the University catalog. A unit is the equivalent of a subject pursued five periods a week for at least thirty-six weeks, four units constituting a year's work.

CURRICULA AND DEGREES

There are four curricula leading respectively to the professional degree of Civil Engineer, Electrical Engineer, Mechanical Engineer and Chemical Engineer. The requirement for a professional degree is 150 credit hours or five years of college work. The work of the first two years is the same in all curricula and will include the following subjects:

English	6 hours
Calculus*	10 hours
Physics	10 hours
Economics	5 hours
Chemistry	5 hours
Drawing	2 hours
Shop	4 hours
Arts electives	18 hours

The other requirements are listed under the various special curricula.

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*Calculus must be preceded by trigonometry and analytic geometry. This will be counted in the Arts electives.

The degree of Bachelor of Science in Engineering may be given at the end of four years of college work for a total of 120 hours credit. This credit must include the required subjects of the first two years as specified above and not less than 45 hours credit selected from the subjects specified for the professional degrees.

Students may obtain both the A. B. and a professional engineering degree in six years. Those who can afford the additional year required are urged to take advantage of the opportunity thus afforded for general cultural training combined with an engineering education. This is made possible by—

(a) The acceptance of the following subjects (to a maximum of 20 credit hours) for the A. B. degree: mechanics (courses 101, 103 and 112); electrical machinery (electrical engineering, course 101) 8 hours; heat engines (mechanical engineering, course 135a), 3 hours; descriptive geometry (mechanical drawing, course 9a or b), 2 hours; elementary surveying (civil engineering, course 102a), 3 hours; woodwork (manual arts, course 1a), 2 hours; metal work (manual arts, course 2a), 2 hours; mechanical drawing (manual arts, course 7a), 3 hours.

(b) The waiving of certain restrictions in the choice of electives in the School of Engineering, for students having an A.B. degree.

Students desiring to take both the A.B. and a professional engineering degree should plan their work carefully from the beginning to insure that the following items are accomplished in their first four years:

1. The completion of all the requirements of the A.B. degree (see the annual catalog).
2. The completion of sufficient electives chosen from the subjects from the School of Engineering that are accepted toward an A.B. degree (see list in paragraph (a) above) to reduce the required engineering courses remaining to be taken in the last two years to a maximum of 60 credit hours.

Curricula meeting all these requirements are not difficult to arrange and considerable latitude may be allowed to satisfy individual needs and inclinations. To assist students in planning their work, a number of suggestive curricula are on file in the office of the dean, School of Engineering.

The courses in engineering require that students be strong in mathematics and physics, and have the scientific spirit. Those who are not qualified in these lines are advised not to undertake work in engineering.

For a full statement of the requirements for entrance, see the annual catalog of the University. This may be secured by addressing the Dean of the University Faculty, University of Missouri, Columbia, Missouri. For special information not found in the catalog, address the Dean of the Faculty of Engineering, University of Missouri, Columbia, Missouri.

CIVIL ENGINEERING

The field covered by this curriculum is wide, embracing topographical, railway, hydraulic, structural, municipal, and highway engineering. It is the aim to give a broad general training which may later serve as a foundation for the development of any special line under the general term, civil engineering.

The curriculum has, therefore, been arranged with the purpose of providing thoro training in those fundamental sciences and principles upon which the practice of the civil engineer is based, and also, in so far as practicable, of giving instruction in the special subjects which underlie the several branches. A number of subjects are made elective, with the object of permitting the student to select his more advanced work in one of the special divisions of civil engineering.

ELECTRICAL ENGINEERING

The curriculum in electrical engineering is intended to prepare students for electrical designing, manufacturing, contracting, and for the installation and management of central and isolated electric light stations, power plants and electric railways. It is planned to furnish insight into and appreciation of the complex problems requiring solution by electrical engineers, while giving thoro, broad training.

The technical work consists of the theory and principles of electricity and magnetism; electrical measurements; calibration of instruments; tests of all kinds; design and construction; study of problems in the generation, transmission, distribution, and utilization of electrical energy.

Special attention is paid to alternating current phenomena.

MECHANICAL ENGINEERING

The curriculum in mechanical engineering is intended to fit young men to secure the greatest advantage from the practical experience which must precede, accompany or follow such a study of the applications of the sciences in a profession; and to enable them to be of earlier and greater responsible value in connection with engineering properties—as designers, installing engineers, in testing and inspection work, in engineering salesmanship or other associated specialties, in power plant operation, in manufacturing, in efficiency improvement, and in the conception, organizing and direction of extended mechanical industrial enterprises.

CHEMICAL ENGINEERING

The rapid development of the chemical industries and the ever increasing demand for engineers trained in the fundamental chemical subjects have led to the introduction of courses in chemical engineering. The curriculum outlined is designed to give a broad and thoro training in general engineering subjects, and in theoretical and applied chemistry. Instruction in chemistry continues thru the whole length of the curriculum. The general principles of physical science are further emphasized by extended courses in mathematics, physics, and mechanics.

The curriculum aims to implant in the students a scientific method of work. Instruction is given by means of recitations, lectures, laboratory work, and conferences. The electives enable the student to give some attention to specialization, but the prime object is to produce a broadly trained chemical engineer.

OUTLINE OF CURRICULA

The professional degrees of Civil Engineer, Electrical Engineer, Mechanical Engineer, and Chemical Engineer are conferred upon the completion of 150 hours' credit, including the first two years work as specified on page 18 and the courses shown in the following tabulations.

The degree of Bachelor of Science in Engineering is conferred upon the completion of 120 hours' credit, including the two years' required of all students, and not less than 45 hours' credit selected from the subjects specified for the professional degree and shown in the following tabulations.

First and second years' work, as specified on page 18, 60 hours.

THIRD YEAR.

DEPARTMENT AND SUBJECT	NO. OF COURSE	SEMESTER 1	SEMESTER 2
Mechanics			
Mechanics of engineering	103	4	4
Civil Engineering			
Elementary Surveying . .	102a or b	0 or 3	3 or 0
Electrical Engineering			
Electrical Machinery . . .	101	4	4
Mechanical Engineering			
Steam Machinery A. . . .	131a or b	3 or 0	0 or 3
Mechanical Drawing			
Machine Drawing.	8a or b	2 or 0	0 or 2
Descriptive Geometry. . .	9a or b	0 or 2	2 or 0
Elective*.		3	3
		16	16

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*The electives recommended for this year include Higher Surveying, C. E. 104b, 4 hours; pattern making, M. A. 3a or b, 2 hours; machine work, M. A. 4, 4 hours, and qualitative analysis, Chemistry, 27a or b, 5 hours.

FOURTH YEAR

DEPARTMENT AND SUBJECT	NO. OF COURSE	CE		EE		ME		ChE	
		1	2	1	2	1	2	1	2
Civil Engineering									
Hydraulics	140a or b	3	...	3	...	3.	...	3	...
Materials of construction	132a	2	...	...	...	...	...	...	...
Graphic Statics	120a	2	...	2	...	2	...	2	...
Railway Surveying	111a	4	...	...	...	...	...	...	...
Sanitary Engineering	152a	2	...	...	...	...	...	...	...
Roads & Pavements	151a	2	...	...	...	...	...	...	...
Framed Structures	121b	...	4	...	...	...	...	...	...
Masonry Structures	125b	...	3	...	...	...	...	...	...
Geology									
Physical Geology	2b	...	3	...	...	...	...	...	...
Mechanical Engineering									
Machine Design A	101b		3		...	...	...	...	3
Materials of Manufacture	102a	...	...	2	...	2	...	2	...
Mechanical Laboratory A	121	...	...	...	...	2	2	...	...
Steam Machinery B	133b	...	...	...	...	...	3	...	...
Machine Design B	103b	...	...	...	...	...	3	...	...
Electrical Engineering									
Advanced Direct Current Machinery	102b	...	...	...	3	...	...	...	...
Advanced Alternating Currents	110a	...	...	3	...	...	...	...	...
Problems Direct Current Design	120b	...	...	...	2	...	...	...	...
Advanced Alternating Current Machinery	111b	...	...	...	4	...	...	...	...
Chemistry									
Organic Chemistry	111	...	...	...	...	...	...	3	3
Quantitative Analysis	121	...	...	...	...	...	...	3	3
Physical Chemistry	131	...	...	...	...	...	...	3	3
Elective		...	2	5	6	6	7	...	3
		15	15	15	15	15	15	16	15

FIFTH YEAR

DEPARTMENT AND SUBJECT	NO. OF COURSE	CE		EE		ME		ChE	
		1	2	1	2	1	2	1	2
Civil Engineering									
Water Power	141a	3	..	...	...	...	...	...	...
Hydraulic Motors	146b	..	...	...	...	...	2	..	...
Specifications and Contracts	191b	..	1	..	1	..	1	..	1
Mechanical Engineering									
Steam Power Plants	134a	..	...	...	...	4	..	...	...
Electrical Engineering									
Generation and Distribution	130b	..	...	...	4	..	...	...	...
Problems in Alternating Current Design	121a	..	...	2	..	...	...	...	...
Physics									
Electrical Measurements	104a	..	...	4	..	...	...	...	...
Chemistry									
Industrial Chemistry	141a or b	..	...	...	...	...	...	...	3
Technical Analysis	122a	..	...	...	...	...	...	3	...
Thesis	199	..	...	1	2	1	2	1	2
Elective*	....	11	13	7	7	9	9	10	7
		14	14	14	14	14	14	14	13

STATEMENT OF COURSES

Courses designated by a number with the letter *a* attached, thus: 100a, are given the first semester only. Those designated by a number with the letter *b* attached, thus: 100b, are given the second semester only. Those designated merely by a number are continuous courses and are given both semesters. Courses numbered 200 and above are strictly graduate in character. *Arabic numerals in parenthesis indicate the number of hours credit a semester.* A full description of courses and schedule of days, hours, and rooms will be found in the annual catalog, which may be obtained by addressing the Dean of the University Faculty, University of Missouri, Columbia, Missouri.

CIVIL ENGINEERING

Topographical Engineering

102a or b. **Elementary Surveying** (3) Mr. WILLIAMS; Mr. LARUE.
103a. **Farm Surveying and Drainage** (3) Mr. WILLIAMS.

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*All elective work required for graduation must be chosen under the advice of a professor in the department in which the student takes his major work, and subject to the approval of the dean.

104b. **Higher Surveying** (3) Mr. Williams.
105b. **Geodetic Surveying** (3) Mr. Williams.
106a. **City Planning** (2) Mr. Williams.
201. **Geodesy and Precise Surveying** Mr. Williams.

Railway Engineering

111b. **Railway Surveying** (4) Mr. Miller.
112b. **Railway Engineering** (3) Mr. Miller.
114a. **Railway Maintenance** (3) Mr. Miller.
115b. **Railway Yards and Terminals** (2) Mr. Miller.
116b. **Signaling and Interlocking** (2) Mr. Miller.
211. **Railway Engineering** Mr. Miller.

Structural Engineering

120a. **Graphic Statics** (2) Mr. Hyde.
121b. **Framed Sructures** (3) Mr. Hyde.
122a. **Structural Design** (4) Mr. Hyde.
123b. **Higher Structures** (3) Mr. Hyde.
124b. **Mill Structures** (2) Mr. Hyde.
125b. **Masonry Structures** (2) Mr. Spalding.
126a. **Concrete Structures** (2) Mr. Spalding.
221. **Bridge Engineering** Mr. Hyde.
222. **Concrete Structures** Mr. Spalding; Mr. Hyde.
223. **Theory of Structures** Mr. Hyde.

Materials of Construction

132a. **Materials of Construction** (2) Mr. LaRue.
133b. **Testing Laboratory** (1) Mr. LaRue.
134b. **Road Materials** (3) Mr. LaRue.
136b. **Cement and Concrete Construction** (1) Mr. Spalding.

Hydraulic Engineering

140a or b. **Hydraulics** (3) Mr. Rodhouse.
141a. **Water Power** (3) Mr. Rodhouse.
142b. **Water Supply** (2) Mr. Rodhouse.
143a. **Irrigation and Drainage** (2) Mr. Rodhouse.
144b. **Rivers and Canals** (2) Mr. Rodhouse.
146b. **Hydraulic Motors** (2) Mr. Rodhouse.
147b. **Hydrology** (2) Mr. Rodhouse.

Municipal Engineering

151a. **Roads and Pavements** (2) Mr. Spalding.
152a. **Sanitary Engineering** (2) Mr. McCaustland.
155a. **Highway Engineering** (2) Mr. Spalding.
156b. **Highway Design** (2) Mr. Spalding.

157b. **Sanitary Design (2)** Mr. McCaustland.
158b. **Rural Sanitation (1)** Mr. McCaustland.
159a. **Country Roads (1)** Mr. Spalding.
251. **Sanitary Engineering** Mr. McCaustland.

General

191b. **Specifications and Contracts (1)** Mr. Spalding.
199. **Thesis** (1) first semester; (2) second semester.

ELECTRICAL ENGINEERING

101. **Electrical Machinery (4)** Mr. Weinbach; Mr. Atkinson.
102a. **Advanced Direct Current Machinery (3)** Mr. Weinbach.
110a. **Advanced Alternating Currents (5)** Mr. Lanier.
111b. **Advanced Alternating Current Machinery (4)** Mr. Lanier.
120b. **Problems in Direct Current Design (2)** Mr. Lanier.
121a. **Problems in Alternating Current Design (2)** Mr. Lanier.
130b. **Generation and Distribution (4)** Mr. Weinbach.
131b. **Electric Motors (2)** Mr. Weinbach.
132a. **Storage Battery Engineering (2)** Mr. Weinbach.
133b. **Illumination (2)** Mr. Atkinson.
134a. **Telephony (2)** Mr. Atkinson.
140b. **Central Station Design (2)** Mr. Atkinson.
141a. **Electric Railway Engineering (2)** Mr. Weinbach.
142b. **Transmission (3)** Mr. Lanier.
143a. **Electrical Processes (2)** Mr. Weinbach.
180a or b. **Application of Mathematics to Electrical Engineering (2)** Mr. Weinbach.
199. **Thesis** (1) first semester; (2) second semester.
231a or b. **Special Electrical Laboratory (2)** Mr. Weinbach.
290. **Research.**

MECHANICAL ENGINEERING

Design

101b. **Machine Design, A (3)** Mr. Hibbard; Mr. Wharton.
102a. **Materials of Manufacture (2)** Mr. Hibbard; Mr. LaRue.
103b. **Machine Design, B (3)** Mr. Fessenden.
104a. **Machine Design, C. (2)** Mr. Fessenden.
201b. **Special Machine Design.** Mr. Hibbard or Mr. Fessenden.

Shop Management

111b. **Shopwork Engineering, A (4)** Mr. Hibbard.
112a. **Scientific Management (3)** M. Hibbard.
114a. **Engineering Office Work (1)** Mr. Hibbard.
211a. **Shopwork Engineering, B** Mr. Hibbard.
212b. **Plants and Equipments.** Mr. Hibbard or Mr. Fessenden [not offered in 1917-18.]

121. **Mechanical Laboratory, A** (2) MR. HANEY.
121. **Mechanical Labratory, A** (2) Mr. HANEY.
122. **Mechanical Laboratory, B** (2) and (1) Mr. HANEY.
123a. **Mechanical Laboratory, C** (2) Mr. WHARTON.
221a and b. **Special Mechanical Laboratory.**

Power Engineering

131a and b. **Steam Machinery, A** (3) Mr. FESSENDEN.
132a. **Thermodynamics, A** (3) Mr. WHARTON.
133b. **Steam Machinery, B** (3) Mr. FESSENDEN.
134a. **Steam Power Plants** (4) Mr. HIBBARD.
135a. **Steam Turbines** (2) Mr. FESSENDEN.
136b. **Prime Movers** (4) Mr. ———; Mr. WHARTON.
137a. **Valve Gears** (2) Mr. FESSENDEN.
138a. **Boiler Design** (2) Mr. FESSENDEN [not offered in 1917-18.]
139a. **Heat Engines** (3) Mr. WHARTON.
231b. **Thermodynamics, B** (2) Mr. WHARTON.
232b. **Advanced Steam Turbine Design.** Mr. FESSENDEN [not offered in 1917-18].
234. **Gas Engineering** (2) Mr. WHARTON [not offered in 1917-18].

Power Applications

151a. **Ventilation and Heating** (2) Mr. FESSENDEN.
153a. **Farm Motors** (2) Mr. WHARTON.
154a. **Refrigeration, A** (2) Mr. WHARTON.
251b. **Refrigeration, B** Mr. WHARTON.

Railway

261. **Railway Mechanical Engineering** (2) Mr. HUBBARD.

The student may elect work in this course along the lines of Railway Shops, Car Design, Locomotive Design, or Locomotive Operation.

General

171b. **Technical Literature** (1) Mr. HIBBARD [not offered in 1917-18].
199. **Thesis,** first semester (1), second semester minimum of (2).
299. **Thesis, Graduate Research.**

CHEMISTRY

27a and b. **Qualitative Analysis** (5) Mr. GIBSON.
111. **Organic Chemistry** (3) Mr. CALVERT.
112a and b. **Preparation of Organic Compounds** (2) or (3) Mr. CALVERT.
113a and b. **Preparation of Organic Compounds and Organic Analysis** (3), (4) or (5) Mr. CALVERT.
121. **Quantitative Chemical Analysis** (3) Mr. GIBSON.
122a. **Technical Analysis** Gas water, and fuel. (3) Mr. GIBSON.
123b. **Technical Analysis** Inorganic commercial products. (3) Mr. GIBSON.
125a. **Quantitative Organic Analysis** (3) Mr. JONES.

126b. **Quantitative Organic Analysis** (3) Mr. Calvert.
127. **Advanced Qualitative Analysis** (2) Mr. Gibson.
131. **Physical Chemistry** (3), (4) or (5) Mr. Schlundt and Mr. Hartman.
133. **Electro-Chemistry** (3), (4) or (5) Mr. Hartman.
135a or b. **Radioactivity** (3) Mr. Schlundt.
141a. **Industrial Chemistry** (3) Mr. Brown.
142b. **Industrial Chemistry** (2) or (3) Mr. Brown.
151a or b. **History of Chemistry** (3)
200. **Chemistry of the Rare Earths** (3) Mr. Brown.
211a and b. **Advanced Organic-Chemistry** (2) or (3) Mr. Calvert.
221. **Advanced Quantitative Analysis** Mr. Gibson.
232a and b. **Advanced Physical Chemistry** Mr. Schlundt.
271. **Research.**

MECHANICS

101. **Elementary Mechanics** (2) Mr. Defoe.
103. **Mechanics of Engineering** (4) Mr. Defoe.
112. **Advanced Mechanics** (4) Mr. Defoe.
205. **Elasticity** (3) Mr. Defoe.
209. **Hydrodynamics** Mr. Defoe.

MANUAL ARTS

1a or b. **Woodwork** (2) Mr. Griffith; Mr. Abbott.
2a or b. **Metalwork** (2) Mr. Allton; Mr. Abbott.
4. **Machine Work** (2) Mr. Brigham.
133b. **Advanced Molding and Foundry Practice** (2).
134a. **Advanced Pattern Making** (2).
135a. **Advanced Forge Work** (2).
136. **Advanced Machine Work** (2) Mr. Brigham.

MECHANICAL DRAWING

6b. **Advanced Lettering** (1) Mr. Newton.
7a and b. **Mechanical Drawing** (2) Mr. Newton.
8a and b. **Machine Drawing** (2) Mr. Newton.
9a and b. **Descriptive Geometry** (2) Mr. Newton; Mr. Miller.
141. **Advanced Machine Drafting** (3) Mr. Newton.

OTHER COURSES

The following courses offered in the College of Arts and Science are of particular interest to students in the School of Engineering:

Astronomy. 1a and b, descriptive astronomy; 103a, geodetic astronomy.

Economics. 1a or b, general economics; 110a or b, problems of labor; 117a or b, accounting; 233a or b, valuation of public utilities.

Geology. 2a or b, physical geology; 4b, rocks and rock minerals; 100a, economic geology; 107a, field geology.

Mathematics. 120a and b, differential equations and their applications.

Physics. 104a, electrical measurements; 110b, electricity and magnetism; 207, theory of electricity and magnetism; 112a, heat; 206, theory of heat; 221b, electrical waves.

GRADUATE WORK IN ENGINEERING

Leading to the Degree of Doctor of Philosophy in the Graduate School

Graduates of the School of Engineering holding professional degrees (C.E., M.E., E.E., Ch.E.) will be admitted to candidacy for the degree of Doctor of Philosophy (Ph.D.) in the Graduate School upon the completion of a minimum of two years of additional work.

Graduates of other schools of engineering in good standing who have completed five years of University work will be admitted on the same basis. A minimum of three years of graduate work will be required of all graduates of engineering schools who have completed only four years of university work.

The faculty of the graduate School reserves the right to pass on the qualifications of all candidates.

The graduate student is expected to devote the major portion of his time to research work. A part of the time may be given to some of the advanced courses offered in engineering, or other university courses allied to the main subject of study.

The work of each candidate is under the supervision of a special committee of the faculty, whose function it is to advise the student in regard to his course of study and the subject of his research.

The usual work consists in the investigation of some engineering problem of practical or scientific importance. In this the student is thrown largely upon his own resources, and must show originality and capability for accurate scientific thinking. The results of the researches are to be embodied in a dissertation which shall give evidence of the merit of the work and the ability of the student. The regulations governing the degree of Doctor of Philosophy are given in the annual catalog.

The equipment and funds of the Engineering Experiment Station are available for experimental research, provided the subjects being investigated are of such practical importance as to conform to the general purpose for which the experiment station was established.

A limited number of research assistants in the engineering experiment station are appointed each year, and under suitable conditions work carried on by these assistants may count toward the doctor's degree. This makes the research assistantship equivalent to a graduate fellowship, enabling the candidate thus appointed to work toward his degree and at the same time earn his expenses during a part of the time.

For further information regarding graduate work, address Dean of the Graduate Faculty, University of Missouri, Columbia, Missouri.

OFFICERS OF INSTRUCTION AND ADMINISTRATION

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Kerr Atkinson, M. E.,
Instructor in Electrical Engineering.

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Instructor in Civil Engineering.

Guy Doric Newton, B. S. in M. E.,
Instructor in Mechanical Drawing and Descriptive Geometry.

James Roy Wharton, B. S. in M. E., M. E.,
Instructor in Mechanical Engineering.

Marshall Henry Brigham,
Assistant in Manual Arts.

Jiles William Haney, B. S. in M. E., M. E.,
Assistant in Mechanical Engineering.

THE ENGINEERING EXPERIMENT STATION

OFFICERS OF THE STATION

ALBERT ROSS HILL, Ph. D., LL. D., *President of the University.*

ELMER JAMES McCAUSTLAND, C. E., M. C. E., *Dean of the Faculty of Engineering, Director of the Engineering Experiment Station.*

The Engineering Experiment Station of the University of Missouri was established by order of the Board of Curators, July 1, 1909.

The object of the station is to be of service to the people of the State of Missouri:

First: by investigating such problems in engineering lines as appear to be of the most direct and immediate benefit and publishing these studies and information in the form of bulletins.

Second: by research of importance to the manufacturing and industrial interests of the state and to engineers.

The staff of the station consists at present of a director and four research assistants together with a number of teachers who have undertaken research under the direction of the station.

Suggestions as to problems to be investigated, and inquiries will be welcomed.

Bulletins have been published as follows:

Vol. 1, No. 1, *Acetylene for Lighting Country Homes*, by J. D. Bowles, research assistant, 1909-10.

Vol. 1, No. 2, *Water Supply for Country Homes*, by K. A. McVey, research assistant, 1909-10.

Vol. 1, No. 3, *Sanitation and Sewerage Disposal for Country Homes, by W. C. Davidson.*

Vol. 2, No. 1, *The heating Value and Proximate Analysis of Missouri Coals*, by C. W. Marx and Paul Schweitzer. (A reprint.)

Vol. 2, No. 2, *Friction and Lubrication Testing Apparatus*, by Alan E. Flowers.

Vol. 2, No. 3, *Tests of Road Materials of Missouri*, by W. S. Williams and Warren Roberts.

Vol. 3, No. 1, *The Use of Metal Conductors to Protect Buildings from Lightning*, by E. W. Kellogg.

Vol. 3, No. 2, *Firing Tests on Missouri Coal*, by H. N. Sharp, research assistant, 1911-12.

Vol. 3, No. 3, *A Report on Steam Boiler Trials Under Operating Conditions*, by A. L. Westcott.

Vol. 4, No. 1, *Economics of Rural Distribution of Electric Power*, by L. E. Hildebrand, research assistant, 1912-13.

Vol. 4, No. 2, *Comparative Tests of Cylinder Oils*, by M. P. Weinbach.

Vol. 4, No. 3, *Artesian Waters of Missouri*, by A. W. McCoy, research assistant, 1912-13.

Vol. 4, No. 4, *Friction Tests on Lubricating Grease and Oils*, by A. L. Westcott.

Engineering Experiment Station Series 14, *A Study of the Effect of Heat on Missouri Granites*, by W. A. Tarr and L. M. Neuman, research assistant, 1913-14.

Engineering Experiment Station Series 15, *A Preliminary Study Relating to the Water Resources of Missouri*, by T. J. Rodhouse.

Engineering Experiment Station Series 16, *The Economics of Electric Cooking*, by P. W. Gumaer.

The following studies are now in progress:

Coal testing
Deep wells and deep well pumping
Artificial illumination
Transmission of heat through boiler surface
Effect of size and quality of sand upon cement mortar
Missouri clays

- Water power in Missouri
- Metallic alloys
- Earth roads and the oiling of roads

besides a number of detailed studies of materials and processes and investigations of Missouri's natural resources.

A standardizing laboratory has been established and the apparatus is now available for test of electric, gas and water meters of practically all types.

Any resident of the state may, on request, obtain bulletins as issued, or if particularly interested, may be placed on the regular mailing list. Address DIRECTOR, ENGINEERING EXPERIMENT STATION, UNIVERSITY OF MISSOURI. COLUMBIA, MISSOURI.

INFORMATION ABOUT THE UNIVERSITY

The fundamental aim of the University of Missouri is the development of the highest and most efficient type of citizen. For the purpose of obtaining its aim, the University furnishes ample facilities for liberal education and for thoro professional training. The University is a part of the public educational system of the state.

ORGANIZATION

The work of the University is now carried on in the following divisions:

- College of Arts and Science
- College of Agriculture
- School of Education
- School of Medicine
- School of Engineering
- School of Mines and Metallurgy
- School of Journalism
- School of Commerce
- Graduate School
- Extension Division

All of these divisions are at Columbia, with the exception of the School of Mines and Metallurgy, which is located at Rolla. In addition, emphasis is given particular lines of work by the establishment of minor divisions, the chief of which are the Agricultural Experiment Station, the Engineering Experiment Station, and the Missouri State Military School.

LOCATION

The University of Missouri is located at Columbia, situated half way between St. Louis and Kansas City, near the center of the state. It is reached by the Wabash and by the Missouri, Kansas and Texas railways. Columbia is a progressive and prosperous town having doubled its population in the last few yers.

Columbia may be characterized as a town of schools, homes, and churches, with enough of industralism to make it efficient. It offers the conveniences of a larger city without the counter attractions. The student is a predominant factor in Columbia.

EQUIPMENT

The University grounds cover more than 800 acres. The main divisions are in the west campus, the east campus, the athletic fields, and the University farm.

The following University buildings are located at Columbia: Academic Hall; New Library building; Laws Observatory; separate buildings for chemistry, physics, biology, commerce and geology, engineering, manual arts, law, two power houses; Library Building; Medical Laboratory Building; Parker Memorial Hospital; Agricultural Building; Horticultural Building; Schweitzer Hall for agricultural chemistry; green houses; Live Stock Judging, Poultry, Dairy, Farm, Machinery, and Veterinary Buildings; the University farm barns and buildings; Switzler Hall for the School of Journalism; Gordon Hotel Building for home economics; Benton and Lathrop Halls, dormitories for men; Read Hall and Sampson Hall, dormitories for women; Rothwell Gymnasium; the houses for the President of the University and the Dean of the Faculty of Agriculture; the High School and the Elementary School buildings, used for practice schools in the School of Education.

FOR FURTHER INFORMATION

For further information concerning the School of Engineering, address

E. J. McCaustland,
Dean, Faculty of Engineering,
University of Missouri,
Columbia, Missouri.

Full information regarding the University is given in the catalog, which will be send on request without charge. For this or special bulletins of the College of Arts and Science, College of Agriculture, School of Education, School of Law, School of Medicine, School of Engineering, School of Journalism, School of Commerce, Extension Division, and the Graduate School, write to

Dean of the University Faculty,
University of Missouri,
Columbia, Missouri.

UNIVERSITY CALENDAR

Session 1916-17, at Columbia

Summer Session

1916	
June 8	Thursday, Registration
June 9	Friday, organization of classes
August 4	Friday, examinations

First Semester

September 14, 15, and 16	Thursday, Friday, and Saturday, entrance examinations	
September 18, 19, and 20	Monday, Tuesday, and Wednesday, registration	
September 20	Wednesday, 11, a. m., opening convocation	
September 21	Thursday, 8 a. m., class work in all divisions begins	
November 1 to December 21	First term, Two-Year Winter Course in Agriculture	
November 29	Wednesday, 4 p. m.	Thanksgiving holidays
	to	
Decemer 4	Monday, 8 a. m.	
December 21	Thursday, 4 p. m.	Christmas holidays
1917	to	
January 3	Wednesday, 8 a. m.	
January 8 to February 23	Second term, Two-Year Winter Course in Agriculture	
January 24	Wednesday	Midyear examinations
	to	
January 31	Wednesday	

Second Semester

February 1, 2	Thursday and Friday, registration, second semester	
February 3	Saturday, 11 a. m., opening convocation	
February 5	Monday, 8 a. m., class work in all divisions begins	
February 22	Thursday, Washington's birthday, holiday	
April 4	Wednesday, 4 p. m.	Easter holidays
	to	
April 10	Tuesday, 8 a. m.	
May 27	Sunday, Baccalaureate address	
May 30	Wednesday, Commencement day	
May 31	Thursday	Final examinations
	to	
June 7	Thursday	

THE
UNIVERSITY OF MISSOURI
BULLETIN

GENERAL SERIES

EDITED BY
H. H. KINYON
University Publisher

The General Series of The University of Missouri Bulletin consists of the announcements of the various colleges and schools which make up the University. These announcements will be sent free upon request to the Dean of the University Faculty, Columbia, Missouri.

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SCHOOL OF ENGINEERING

ANNOUNCEMENT 1919-20

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APRIL, 1919

THE UNIVERSITY OF MISSOURI BULLETIN
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SCHOOL OF ENGINEERING

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FOREWORD

Opportunities for Engineering Graduates in the Industries.

Now that the war has come to a close, special attention is directed to the fact that in times of peace industrial preparedness should receive much greater consideration than was accorded it before the war. No problem confronting the Nation touches the life of the people at so many points.

The activities of the recent war served to emphasize the great need for a more general extension of technical training. Such training has a value outside the narrow limits of professional application and it has fully demonstrated its value in the field of general business and public affairs. Special plans are in process of formulation that will enable underclassmen in the School of Engineering to come more closely in contact with business and industrial affairs. It is hoped that this contact will serve to motivate the work of the student and to assist him in giving direction to his preparation.

The consensus of engineering judgment thruout the country favors an increasing attendance at the technical schools in order to prepare a large number of trained men to meet the pressing needs of the near future.

The field of engineering and technical training is especially commended to those who may be contemplating a preparation for their life work, and who feel that their ability to serve their country to the best advantage may lie along lines developed by technical training.

The War Department is seeking to make use of the advantages of engineering training in the universities of the country, and the Chief of Engineers of the United States Army has reported favorably upon the School of Engineering of the University of Missouri as a place for the organization of an engineering unit in the Reserve Officers Training Corps. The outlook in the field of engineering is especially encouraging to young men of character, ability, and willingness to work.

THE MODERN ENGINEER AND HIS RELATION TO SOCIETY

About the middle of the nineteenth century the industrial development which had followed the invention of the steam engine became so highly specialized that engineers found it necessary to restrict their individual fields of practice. Previous to this period, engineering had developed out of the needs of the military and later the needs of civil organizations, thus producing two classes in the profession known respectively as military engineers and as civil engineers, with no further division into specialties. Progress in the art of engineering came thru the extension of practice rather than from a study of the fundamental laws of science underlying the art. The modern point of view, however, emphasizes the value of a thoro knowledge of the laws of science which serve as the foundation upon which the practice of the profession may be developed.

The study of present social conditions in the civilized world reveals the fact that the advances of the last one hundred and fifty years are founded largely on the work of the engineer whose application of the discoveries of modern science has brought about conditions leading to improved health, comfort and the conveniences of living. The economic history of the past century is also closely interwoven with, and to a large degree dependent upon the inventions and mechanical developments of the engineer.

These facts give emphasis to the statement that there are excellent opportunities in modern life and industry for able and well trained engineers. The financial rewards are not usually as great as may be gained in commercial life altho there is a distinct tendency at the present time to value more highly and to increase the compensation for the services of engineers. However, the true engineer has an enthusiasm for his work which makes opportunity for service more attractive to him than the opportunity for personal gain.

Engineers find employment in the service of various corporations, as designing engineers for structural work or for machines, and finally after considerable experience, they may prosper as independent consulting engineers. Many abandon technical practice altogether and enter administrative or managerial positions or seek service in the business organizations of industrial enterprises.

The development of governmental control of public utilities opens a way for the employment of many engineers who may be called upon to fix rates and enforce standards of quality, quantity and service; their judgment may be needed also to authorize or forbid bond issues, depending upon the financial and physical condition of the corporation. In the exercise of these and similar functions, the engineer should be well equipped with technical knowledge, and he should also have some understanding and appreciation of the legal, economic, commercial, social and ethical questions involved in such problems as valuation and rate fixing.

The rapid growth of public ownership of utilities such as the municipal ownership of electric light and power, water, gas and transportation plants, opens the way for further work for the engineer. The earlier type of municipal engineer whose practice was largely confined to planning and overseeing the construction and maintenance of streets and pavements, sewers, parks and water mains, was best trained as a civil engineer. For municipalities owning and operating their public utilities such as water supply, power and light plants, etc., the office of city engineer may well be filled by a mechanical or electrical engineer.

The development of engineering into specialties has become a characteristic of modern practice and schools recognize this in the outlining of curricula. Some of these special fields are briefly outlined below.

DIVISION INTO SPECIALTIES

AGRICULTURAL ENGINEERING

The most recent subdivision of engineering has to do with the applications of the art to agricultural problems such as drainage, irrigation, water supply and sewerage for the farm, design of farm machinery, etc. The field open to agricultural engineers ranges all the way from strictly engineering work to the general management of large farm operations. Many drainage and irrigation projects intended to develop agricultural resources have failed because attention was concentrated upon the engineering features and little attention given to agricultural phases of the problem until the work was practically completed.

Training in agricultural engineering contemplates a thoro understanding of the elementary principles underlying both agriculture and engineering.

CHEMICAL ENGINEERING

Engineers with special training in chemistry, who devote themselves to the development of the various chemical industries, are known as chemical engineers. Much of recent progress is due to the discovery and development of new materials and compounds with characteristics that make them valuable in the arts. A great part of the research being carried on for commercial purposes lies along these lines. A man who has had a thoro training in chemistry, and who combines with his knowledge of chemistry an insight into physical and mechanical problems and an appreciation of the commercial significance of his work, is best qualified to make himself valuable in investigation of this kind. Not only the discovery of new products, but the maintenance of a standard of quality in manufactured materials, demands the labor of men who have a knowledge of chemistry.

This field of work is rapidly becoming very large because of the many and varied industries which have been and are being developed.

CIVIL ENGINEERING

The term civil engineering is still often used in its original sense as covering all engineering not military, but commonly it is limited to those fields of practice not included in the other branches.

In the number of special fields of work included, it is the broadest branch of engineering practice. It comprises:

Surveying, which in simple forms is used by all civil engineers, but which when applied in geodetic and topographic work may constitute a distinct field of practice.

Hydraulic engineering, which includes the design and construction of harbors and docks, river improvements, canals, irrigation works, drainage and flood prevention, and water power projects.

Sanitary engineering, covering all works designed to protect the public health, such as water supply and water purification, sewerage and sewage disposal, and the disposal of garbage and refuse.

Highway engineering, in which may be included both the maintenance and improvement of country roads and the construction and maintenance of city streets and pavements.

Railway engineering, which deals with the design, construction, and maintenance of all works required for steam and electric railways.

Structural engineering, which is concerned with the design and construction of bridges and of the structural features of large buildings that carry heavy loads, masonry and concrete structures, and heavy foundations.

General construction, under which head may be included the execution of large works of construction, and the transportation and handling of heavy materials.

ELECTRICAL ENGINEERING

Engineers who are concerned mainly with the generation, transmission, or utilization of electrical energy are known as electrical engineers.

The last few years have seen a great increase in the applications of electricity, and the field of its usefulness is constantly widening. The special fields of most importance into which electrical engineering is divided are:

The design and construction of generators, motors, and other apparatus required in the generation, distribution, and utilization of electric power.

The design, construction, and operation of plants for generating electric power and lines for its transmission.

The application of electricity to industrial power.

The building and operation of electric railways.

The utilization of electric energy for lighting purposes.

The design, construction, and operation of telephone and telegraph systems.

The application of electricity in the various chemical industries.

MECHANICAL ENGINEERING

The term mechanical engineering is usually employed to designate the work of those engineers who have to do primarily with steam or other engines, machine tools, mill work, and moving machinery in general. The lines of work included in the practice of a mechanical engineer may be:

Power engineering, which consists in the design, construction and operation of machines and plants for the generation of power. These may include steam, gas, oil, or other engines, with all the auxiliary appliances necessary to their operation, as well as the various methods of power distribution.

Design of plants and machinery for the utilization of power, requiring the study of special processes for which machinery may be required, and the adaptation of machines and arrangement of plants for purposes of economical production.

Shop management, dealing with the control and management of shops in the operation of manufacturing plants.

Gas engineering, covering the production, distribution, and utilization of gas for light, heat, and power purposes.

Railway mechanical engineering, consisting of the design, construction, and operation of rolling stock and other machinery, and of the shops required in the operation of railways.

THE SCHOOL OF ENGINEERING

BUILDINGS AND EQUIPMENT

The departments of electrical and mechanical engineering of the University of Missouri at Columbia occupy the main Engineering Building and the department of civil engineering occupies a part of Switzler Hall. The work in chemistry, required of students in chemical engineering is given in the Chemistry Building and the specialized work in agricultural engineering is offered in the Farm Machinery Building.

The main engineering laboratories are in the Engineering Annex in the rear of the Engineering Building. A substantial addition to the Engineering Annex is now being used for the expansion of the mechanical engineering laboratory and for the development of a hydraulic laboratory. Shop work is conducted in a building recently erected for the purpose.

Agricultural Engineering. This laboratory contains a large assortment of the best modern machinery, including one or more samples of the principal field and power machines. A line shaft driven by an electric motor is available for demonstrating these machines.

For instruction in gas engines and tractors, the laboratory is equipped with ten stationary and portable gasoline and oil engines and samples of the latest type of tractors with suitable equipment for testing them. Lighting units are provided for work on farm lighting systems. Drafting tables are provided to accommodate the men designing farm buildings.

The equipment for concrete work includes a complete set of concreting tools, molds for building blocks, forms for fence posts, water troughs, and tanks and tile machines, with small apparatus for testing cement and aggregates. A level and transit with complete set of tools are provided for tile drainage work.

Chemical Engineering. In addition to the laboratories in general chemistry, there are separate laboratories for the other fundamental courses in chemistry required in the chemical engineering curriculum. The general analytical laboratory offers facilities for work in qualitative and quantitative analysis. Special work in the technical analysis of fuels, water, gas, and commercial products is given in smaller laboratories equipped especially for these lines of work. Two laboratories are available for general work in organic chemistry, and more advanced work along organic lines is provided for in a furnace room and a laboratory for the preparation of organic compounds. The laboratory in physical chemistry is equipped for work in electro-chemistry and measurements in radio-activity. Advanced students have an opportunity to pursue work in metallography. The electrical laboratories in the Engineering Building offer facilities for work in electro-plating, storage battery engineering, and electrical processes.

Civil Engineering. The laboratory for testing materials is in charge of the department of civil engineering. The equipment includes several vertical testing machines with all necessary accessories for tension, compression, and transverse tests on the ordinary engineering materials, iron, steel, cement, concrete, brick; a beam-testing machine; a torsion machine; impact and abrasion machines. There is also complete equipment for all the standard tests upon hydraulic cement.

The road materials laboratory contains the necessary machine for making complete tests upon stone for road purposes, a standard rattler for paving brick tests, and the apparatus required in investigating bituminous road materials.

There is a good collection of surveying instruments, including the instruments used in ordinary field practice and those necessary for precise surveying and geodetic work.

Stream gages, with a dam and weirs on streams near Columbia, afford opportunity for field study of water supply problems, while practice in hydrographic surveying and stream measurement is obtained by a trip to a river in the neighborhood.

Hydraulic Laboratory. A new hydraulic laboratory has been equipped recently for the study of problems where large quantities of flowing water are needed. Two large size direct-connected electric motor-driven centrifugal pumps have been installed. These pumps will supply water for investigations relating to the flow of water in flumes, large pipes, and conduits; to the discharge over dams and weirs, thru racks, sluices, and submerged orifices; and to other features encountered in the water power and water supply developments.

Apparatus has been installed for the study of the flow of water thru pipes, fire hose and nozzles, and the effect of valves and bends; for the study of the flow of water thru sand filters, and of ground-water flow in soil drainage; and for the testing of pumping machinery and water wheels.

Full equipment for the accurate measurement of quantities, velocities, and pressures, both in open and closed channels is available, and includes the latest types of Pitot tubes, automatic self-recording gages and water meters.

Electrical Engineering. The electrical engineering laboratory contains direct and alternating current generators and motors of the common types met with in practice and all the instruments necessary to make complete tests of their operation. Besides several low-ratio transformers used in routine exercise, the laboratory has a 10,000-volt transformer for testing dielectric strengths, one of 40,000-volts and one 10 KVA of 100,000 volts for high tension experiments. A set of Edison cells and one of chloride cells are available for experiments on storage batteries.

A low voltage motor-generator set is provided for general electro-chemical processes such as electro-plating with gold, silver, nickel, and copper. One large and several small electric furnaces are used for demonstrations of the electric processes involved in the production of carborundum, graphite, emery, calcium carbide, ferro-alloys.

The telephone equipment comprises a demonstration board showing all the apparatus and operations involved in a connection thru two offices. For experiments in telephone transmission, there is a high frequency generator and an artificial line, which is electrically equivalent to fifty miles of underground wire.

The laboratory also has a quadruplex telegraph set.

Mechanical Engineering. The mechanical engineering laboratory contains several different types of steam engines, a small steam turbine with a superheater, condensers, gas engines, reciprocating and centrifugal pumps, a number of fans, blowers, and heating coils for work on ventilation and heating, and a variety of other machinery. Much attention is paid to the study of fuels of all kinds. Complete standard apparatus for determining the analysis and calorific value of coals and gases is provided. The laboratory is supplied with the usual equipment of indicators, gases, water and gas meters, scales, and other necessary accessories.

The central power plant of the University is used for conducting boiler tests under actual operating conditions. Considerable attention is given to the study of refrigeration. Several small ice and cold storage plants belonging to the University are available for tests. A local privately owned plant is also sometimes used.

A high grade lathe, completely equipped for use in connection with courses in shop efficiency, has been purchased recently. It will be used to make production tests to determine the proper kinds of tools and the best cutting speeds to use in making machine parts.

Library. The engineering library in the Engineering Building has 5,000 standard engineering books. These have been carefully selected and include the works of all the best American and English engineering authors. About 100 periodicals are regularly received, together with publications recording the transactions of the more important engineering societies.

Engineering students are permitted free access to the library shelves for reference and are encouraged to draw books for outside reading.

The general library of the University and the library of the State Historical Society, together containing about 250,000 books and pamphlets, are open to all students in the University.

STUDENT ACTIVITIES

ENGINEERING SOCIETIES

The Engineers' Club is made up of students from all classes and as its main function affords opportunities for close acquaintance among the students in the school.

Branches of two national engineering societies, the American Institute of Electrical Engineers and the American Society of Mechanical Engineers, have been established for several years. Meetings of each are held semi-monthly for the discussion of current engineering problems, usually drawn from the publications of the national societies received regularly by the members of the branches. Practically all of the upperclassmen in electrical engineering and mechanical engineering are active members of one or the other of the branches, and a great deal of interest is taken in the meetings.

These societies are strongly encouraged because of the benefits to be derived from practice in preparing and delivering papers before a critical audience and for the acquaintance with the activities of the prominent engineers composing the national societies.

During 1913, the Civil Engineers' Society, working along lines similar to those followed by the branches discussed above, was organized. This society is not affiliated with a national society.

ATHLETICS

Students in all divisions of the University are encouraged to take part in athletics in one form or another. Class teams and Varsity teams are maintained in football, baseball, basketball, tennis and track. These are all carefully supervised and are under the direction of the experienced coaches and trainers.

Rothwell Gymnasium is well lighted and well ventilated and equipped with the usual apparatus. Bathing, locker, and dressing facilities are provided in the basement. During good weather much of the systematic work is carried on in an outdoor gymnasium arranged near Rothwell Gymnasium.

Rollins Field, named in recognition of the generosity of members of the Rollins family, is just west of Rothwell Gymnasium. It contains a quarter-mile cinder track, 220-yard straight away, grounds for field athletics, a gridiron for football, and a baseball field. All intercollegiate contests are held here.

Concrete bleachers which seat 4,250 persons have been constructed. A new concrete fence with ornamental gate partially surrounds Rollins Field.

Tennis courts, basketball courts, baseball, football, and soccer fields for all students are situated near the gymnasium.

MILITARY AND PHYSICAL TRAINING

Required. All physically fit male students of the University at Columbia are required to take, unless excused for cause, during the first four terms of their freshman and sophomore years, the prescribed course of training (3 hours a week) in the department of military science and tactics. Four hours' credit toward graduation is allowed for this work.

Advanced Course. Any student who has completed two academic years in the course, and who has been selected for further military training, may be enrolled for an advanced course of four terms, upon executing an agreement in writing. *Students taking the advanced courses* (5 *hours a week*) *will be paid commutation of subsistence by the United States.* Upon completion of the advanced course, they are eligible for appointment in the Officers' Reserve Corps, and as temporary second lieutenants in the Regular Army. Eight hours' credit toward graduation is allowed for this work.

Physical Training. All students are required to take two terms of physical training during the freshman year.

FEES AND EXPENSES

Tuition. Tuition is free in all divisions of the University to students who are residents of the state. Non-residents of the state are required to pay a tuition fee of $10 a term in all divisions of the University, except in the Graduate School.

Library, Hospital, and Incidental Fee. All students in the University except those enrolled in the short winter courses in agriculture, and except those specially exempt by law or by rule of the Curators,* are required to pay a library, hospital, and incidental fee of $15 a term.

Laboratory Deposits. Each student entering a laboratory is required to make a deposit of $5, unless a different amount be fixed by the President of the University and the director of the laboratory. From the amount deposited there is deducted a fixed charge (in no case less than $1, for each individual laboratory course), and also all charges for materials used or for damages to or loss of University property. If the deposit is insufficient to cover all such charges the student is required to make an additional deposit or deposits. When damage or loss is sustained by a laboratory, it is assessed against the deposits of students using the laboratory at the time of the damage or loss, unless such damage or loss be traced to some individual student or students. The remainder of any deposit, after payment of all charges, is refunded to the student at the end of his laboratory course in any session, provided it be called for within twenty days after the close of the session. If not so called for, the amount will be credited to the laboratory in which the deposit was made. For details consult the annual catalog. All fees and deposits must be paid in advance.

Books and Instruments. The cost of books varies considerably depending upon the courses being taken each year; a fair average is from $10 to $15 a term. A good set of drawing instruments is required in the first year's work in mechanical drawing and is used thruout the course. This costs from $10 to $20, depending upon the quality.

Room Rent and Board. Rooms may be rented in Lathrop Hall, the University dormitory for men, at from $10 to $18 for each student for a term of sixteen weeks. Two students occupy each room and the rent depends upon the location of the room.

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*See the annual catalog.

For rooms in private houses, from $8 to $16 a month is charged the average being about $12. This is usually shared by two students.

The Commons, run under the direction of the University, consists of a cafeteria in Lathrop Hall. The average cost of meals served in the cafeteria is 19 cents.

Board in private boarding houses usually costs from $5 to $6 a week. Private boarding clubs are formed in which the average cost is about $4.50 a week.

Total Expenses. The table below is intended to give an idea as to the probable expenses per term of a student in the School of Engineering:

	Low Estimate	Medium Estimate	Very Liberal Estimate
Library, hospital and incidental fee*	$15	$15	$15
Room rent	12	25	40
Board	60	75	100
Laboratory deposits	8	10	15
Books	8	12	20
Laundry	10	15	25
Society dues and assessments	2	5	15
Incidentals, amusements, etc.	10	20	50
	$125	$177	$280

Clothing and railroad fares are not included in this table. The actual expenditures will depend largely upon the tastes and inclinations of the individual student. The low estimate in the table is considered to be about the minimum required consistent with comfortable quarters and good food. It implies rigid economy in all things. The medium estimate is thought to be about the average amount spent by students in the School of Engineering.

There are many opportunities for a student to earn money to pay part or all of his expenses at Columbia. The University conducts an employment bureau to aid students in finding work of this kind. Students who must spend part of their time in outside employment should not expect to take full work in the University and under these circumstances an additional year is often required to satisfy the requirements for graduation. Students coming to Columbia for the first time should not expect to find work at once, but must have some funds available to meet necessary expenses until employment is obtained. This may require several months. Information regarding employment may be had by addrssing, Secretary, Employment Bureau, Y. M. C. A. Building, Columbia, Mo.

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*Under certain conditions students are exempt from the library, hospital, and incidental fee. For particulars, see the annual catalog.

REQUIREMENT FOR ADMISSION

Fifteen units, the equivalent of a 4-year high school course, are required for admission as a regular student in the School of Engineering.

A unit is the equivalent of a subject pursued five periods a week for at least thirty-six weeks, four units constituting a year's work.

CURRICULA AND DEGREES

There are five curricula leading respectively to the professional degrees of Agricultural Engineer, Chemical Engineer, Civil Engineer, Electrical Engineer, and Mechanical Engineer. The requirement for a professional degree is 155 credit hours or ten terms of college work. The work of the first four terms is the same in all curricula and is outlined in the tables which follow. The additional requirements are further tabulated and listed.

The degree of Bachelor of Science in Engineering may be given at the end of eight terms of college work for a total of 125 credit hours as shown in the following tables.

Students may obtain both the A. B. and a professional engineering degree in twelve terms. Those who can afford the additional time required are urged to take advantage of the opportunity thus afforded for general cultural training combined with an engineering education. This is made possible by—

(a) The acceptance of the following subjects (to a maximum of 20 credit hours) for the A. B. degree: mechanics (courses 101, 103 and 112); electrical machinery (electrical engineering, courses 101 and 102) 8 hours; applied thermodynamics (mechanical engineering, course 231), 3 hours; descriptive geometry (mechanical drawing, course 2), 2 hours; elementary surveying (civil engineering, course 102), 3 hours; woodwork (manual arts, course 1), 2 hours; metal work (manual arts, course 2,) 2 hours; mechanical drawing (mechanical drawing, course 1), 3 hours.

(b) The waiving of certain restrictions in the choice of electives in the School of Engineering, for students having an A.B., degree.

Students desiring to take both the A.B. and a professional engineering degree should plan their work carefully from the beginning to insure that the following items are accomplished in their first eight terms:

1. The completion of all the requirements of the A.B. degree (see the annual catalog).
2. The completion of sufficient electives chosen from the subjects from the School of Engineering that are accepted toward an A.B. degree (see list in paragraph (a) above) to reduce the required engineering courses remaining to be taken in the last four terms to a maximum of 60 credit hours.

Curricula meeting all these requirements are not difficult to arrange and considerable latitude may be allowed to satisfy individual needs and inclinations. To assist students in planning their work, a number of suggestive curricula are on file in the office of the dean, School of Engineering.

The courses in engineering require that students *be strong in mathematics and physics, and have the scientific spirit. Those who are not qualified in these lines are advised not to undertake work in engineering.*

For a full statement of the requirements for entrance, see the annual catalog of the University. This may be obtained by addressing the Registrar, University of Missouri, Columbia, Missouri. For special information not found in the catalog, address the Dean of the Faculty of Engineering, University of Missouri, Columbia, Mo.

AGRICULTURAL ENGINEERING

(*Administered jointly by the Dean of the Faculty of Agriculture and the Dean of the Faculty of Engineering.*)

The demand for men trained in engineering as applied to different phases of agriculture has led to the introduction of a curriculum in agricultural engineering. This curriculum emphasizes the fundamentals of engineering subjects, makes the student familiar with modern scientific agriculture and gives him a training in agricultural engineering.

The training contemplated will fit men for professional work in that line of engineering where an agricultural viewpoint is necessary, such as problems in drainage and irrigation, planning for buildings, and design of farm machinery. It will fit men for government and teaching positions, to be experts and salesmen with farm machinery manufacturers, and will prepare them to take charge of large farms where engineering applications in agriculture are important factors.

CHEMICAL ENGINEERING

The rapid development of the chemical industries and the ever increasing demand for engineers trained in the fundamental subjects have led to the introduction of coures in chemical engineering. The curriculum outlined is designed to give a broad and thoro training in general engineering subjects and in theoretical and applied chemistry. Instruction in chemistry continues thru the whole length of the curriculum. The general principles of physical science are further emphasized by extended courses in mathematics, physics, and mechanics.

The curriculum aims to implant in the students a scientific method of work. Instruction is given by means of recitations, lectures, laboratory work, and conferences. The electives enable the student to give some attention to specialization, but the prime object is to produce a broadly trained chemical engineer.

CIVIL ENGINEERING

The field covered by this curriculum is wide, embracing topographical, railway, hydraulic, structural, municipal, and highway engineering. It is the aim to give a broad general training which may later serve as a foundation for the development of any special line under the general term, civil engineering.

The curriculum has, therefore, been arranged with the purpose of providing thoro training in those fundamental sciences and principles upon which the practice of the civil engineer is based, and also, in so far as practicable, of giving instruction in the special subjects which underlie the several branches. A number of subjects are made elective, with the object of permitting the student to select his more advanced work in one of the special divisions of civil engineering.

ELECTRICAL ENGINEERING

The curriculum in electrical engineering is intended to prepare students for electrical designing, manufacturing, contracting, and for the installation and management of central and isolated electric light stations, power plants, and electric railways. It is planned to furnish insight into and appreciation of the complex problems requiring solution by electrical engineers, while giving thoro, broad training.

The technical work consists of the theory and principles of electricity and magnetism; electrical measurements; calibration of instruments; tests of all kinds; designs and construction; study of problems in the generation, transmission, distribution, and utilization of electrical energy.

Special attention is paid to alternating current phenomena.

MECHANICAL ENGINEERING

The curriculum in mechancial engineering is intended to fit young men to get the greatest advantage from the practical experience which must precede, accompany or follow such a study of the applications of the sciences in a profession; and to enable them to be of earlier and greater responsible value in connection with engineering properties— as designers, installing engineers, in testing and inspection work, in engineering salesmanship or other associated specialties, in power plant operation, in manufacturing, in efficiency improvement, and in the conception, organizing, and direction of extended mechanical industrial enterprises.

CURRICULA IN ENGINEERING 1919-20

FIRST YEAR

Subject	Department and Course No.	Term	
		Fall	Winter
Trigonometry and algebra	Math. 2f.	5	
Analytic geometry	Math. 4w.		5
Composition and rhetoric	English 1f., 2w.	3	3
General inorganic chemistry	Chem. 1f. or w.	0 or 5	5 or 0
Woodwork	M. A. 1f. or w.	2 or 0	0 or 2
Metalwork	M. A. 2f. or w.	2 or 0	0 or 2
Mechanical drawing	M. D. 1f. or w.	2	
Descriptive geometry	M. D. 2f. or w.		2
Military science and tactics		1	1
Physical training		½	½
		15½ or 16½	16½ or 15½

SECOND YEAR

Subject	Department and Course No.	Ag.E.		Ch.E.		C. E.		E. E.		M. E.	
		F	W	F	W	F	W	F	W	F	W
Diff. calculus	Math. 5f.	5		5		5		5		5	
Int. calculus	Math. 6w.		5		5		5		5		5
Gen. physics	Physics 3f, 4w.	5	5	5	5	5	5	5	5	5	5
Gen. economics	Econ. 1f. or w.				5		5		5		5
Elementary surveying	C. E. 102f, or w.					3		3		3	
Machine drawing	M. D. 3f. or w.					2		2		2	
Inorg. chemistry	Chem. 2f.			3							
Qual. analysis	Chem. 27f.			3							
Farm crops	F. C. 1f.	5									
Anal. chem.	Chem. 25w.		5								
Military science and tactics		1	1	1	1	1	1	1	1	1	1
		16	16	17	16	16	16	16	16	16	16

THIRD YEAR

Subject	Department and Course No.	Ag.E.		Ch.E.		C. E.		E. E.		M. E.	
		F	W	F	W	F	W	F	W	F	W
Mechanics of eng.	Mech. 103f. 104w.	4	4	4	4	4	4	4	4	4	4
Electrical mach.	E. E. 101f. 102w.	4	4	4	4	4	4	4	4	4	4
Heat mach. A	M. E. 131f. or w.				3	3		3			3
Machine design A	M. E. 101w.				3		3		3		3
Elementary surveying	C. E. 102f. or w.	3		3							
Pattern making	M. A. 3f. or w.										2
Machine work	M. A. 4f.									4	
Quant. chem. analysis	Chem. 121f. or w.			5							
Machine drawing	M. D. 3f.				2						
Higher surveying	C. E. 104w						4				
Materials of constr.	C. E. 132f.	2						2			
Hydraulics	C. E. 140f. or w.		3						3		
Farm machinery and farm motors	A. E. 2f.	3									
Soil physics	Soils 1w		5								
Elective						5		2	2	3	
		16	16	16	16	16	15	15	16	15	16

FOURTH YEAR

Subject	Department and Course No.	Ag.E.		Ch.E.		C. E.		E. E.		M. E.	
		F	W	F	W	F	W	F	W	F	W
Hydraulics	C. E. 140f. or w.				3	3				3	
Graphic statics	C. E. 120f.			2		2		2		2	
Materials of constr.	C. E. 132f.			2		2				2	
Railway surveying	C. E. 111f.					3					
Sanitary engineering	C. E. 152f.					2					
Framed structures	C. E. 121w.						5				
Masonry "	C. E. 125w.						3				
Roads and pavements	C. E. 151f.	2				2					
Irrigation and drain	C. E. 243f.	2									
Adv. D. C. machinery	E. E. 103f.							3			
Adv. A. C.	E. E. 110f.							3			
Probs. in D. C. design	E. E. 120w.								2		
Adv. A. C. machinery	E. E. 111w.								4		
Mechan. lab. A	M. E. 121f., 122w.									2	2
Heat mach. A	M. E. 131f. or w.	3									
Heat mach. B	M. E. 132f., 133w.							3		3	3
Machine design B	M. E. 103w										3
Farm buildings	A. E. 1w.		4								
Rural sanitation	A. E. 5w.		2								
Adv. farm motors	A. E. 103f.	2									
Physical geology	Geol. 2w.						3				
Organic chemistry	Chem. 110f., 111w.			3	3						
Physical chemistry	Chem. 131f.			5							
Soil management	Soils 2w.		3								
Principles of econ.	Rur. Ec. 2w.	3									
Types and clases of livestock	A. H. 1w.		3								
Elective		2	3	2	8	1	4	4	9	3	7
		14	15	14	14	15	15	15	15	15	15

Note: The 5 hours' elective work in the agricultural engineering curriculum, the 10 hours in the civil engineering, and at least 12 hours of the elective work in the other curricula must be taken in divisions other than engineering.

For the degree of Bachelor of Science in Engineering, at least two months' experience in some field of engineering or activity closely allied to engineering is required.

FIFTH YEAR

AGRICULTURAL ENGINEERING

Required Work:

			Hours
C. E.	291w.	Specifications and contracts	1
"	142w.	Water supply	2
Hort.	110f.	Landscape design	2
F. M.	110w.	Farm organization	3
A. E.	102w.	Irrigation and drainage	2
"	200f. or w.	Thesis	3
			13

At least 8 hours to be selected from the following group:

C. E.	120f.	Graphic statics	2
"	125w.	Masonry structures	3
E. E.	121w.	Electric motors	3
M. D.	3f.	Machine drawing	2
M. E.	151f.	Heating and ventilation	3
"	154f.	Refrigeration	3
"	101w.	Machine design	3
Hort.	112w.	Spraying	2
F. C.	3f.	Field crop management	2
			23

CHEMICAL ENGINEERING

Required Work:

C. E.	291w.	Specifications and contracts	1
Chem.	141f.	Industrial chemistry	3
"	122f.	Quantitative chemical analysis	5
"		Thesis	3
			12

At least 8 hours to be selected from the following group:

Chem.	112f.	Organic chemistry	3
"	125w.	Quantitative organic analysis	5
"	133w.	Electro chemistry	5
"	135w.	Radioactivity	3
"	142w.	Industrial chemistry	3
"	211f.	Advanced organic chemistry	3
"	227w.	Advanced analytical chemistry	2 to 5
"	201w.	Advanced inorganic chemistry	3
"	232	Advanced physical chemistry	3
Physics	104f.	Electrical measurements	4
Geol.	106f.	Mineralogy	5
Botany	3f.	General bacteriology	3
		Total	42 to 45

CIVIL ENGINEERING

Required Work:

C. E.	112f.	Railway location and construction	2
"	113w.	Economics of railway construction	2
"	222f.	Structural design	3

”	133w. Testing laboratory	1
”	141f. Water power	3
”	291w. Specifications and contracts	1
		12

At least 8 hours to be selected from one of the following groups:

I.—Railway and Structural.

C. E.	214w. Railway engineering	3
”	215w. Railway yards and terminals	2
E. E.	241w. Electric railway engineering	2
C. E.	223w. Higher structures	3
”	226f. Concrete structures	3
”	201w. Geodetic surveying	3
		16

II.—Hydraulic and Geological.

C. E.	142w. Water supply	2
”	243w. Irrigation and drainage	2
”	244w. Rivers and canals	2
”	201w. Geodetic surveying	3
”	226f. Concrete structures	3
Geol.	108w. Rocks and rock minerals	3
”	100f. Economic geology	3
		18

III.—Municipal and Highway.

C. E.	157w. Sanitary design	2
Botany	3f. General bacteriology	3
C. E.	142w. Water supply	2
”	106f. City planning	2
”	134w. Road materials	3
”	155w. Highway engineering	2
”	256f. Highway design	2
		16

ELECTRICAL ENGINEERING

Required Work:

E. E.	221f. Problems in A. C. design	2
”	230f. or w. Generation and distribution	3
Physics	104f. Electrical measurements	4
C. E.	291w. Specifications and contracts	1
E. E.	298f, 299w. Thesis	3
		13

At least 8 hours to be selected from the following groups:

I.—Power Group.

E. E.	242w. Transmission	3
”	240w. Central station design	2
C. E.	141f. Water power	3
M. E.	133w. Heat machinery B.	3
”	131f, 122w. Mechanical laboratory A.	4
”	234f, 235w. Gas engineering	4
		19

II.—Design Group.

E. E.	244w.	Analysis of design problems	2
M. E.	103w.	Machine design, B.	3
E. E.	240w.	Central station design	2
"	250f.	Special electrical laboratory	2
"	280w.	Application of mathematics to E. E.	2
C. E.	124w.	Mill structures	2
			13

MECHANICAL ENGINEERING

Required work:

C. E.	291w.	Specifications and contracts	1
M. E.	111f.	Management engineering	3
"	151f.	Heating and ventilation	3
"	234f. 235w.	Gas engineering	4
			11

At least 8 hours to be selected from one of the following groups:

I.—Power Group.

C. E.	141f.	Water power	3
M. E.	134f.	Steam power plants	4
"	135f.	Steam turbines	2
"	231w.	Applied thermodynamics	3
"	154f.	Refrigeration, A.	3
"	251w.	Railway mechanical engineering (locomotive)	2
			17

II.—Design and Manufacturing Group.

E. E.	131w.	Electric motors	2
"	133f.	Illumination	2
C. E.	133w.	Testing laboratory	1
M. E.	102f.	Technology of metals	2
"	104f.	Machine design	2
"	172w.	Engineering charts	1
"	211w.	Shopwork engineering	2
"	262w.	Railway mechanical engineering (design)	2
			14

Note:—Students electing any one of the above groups, who are interested in the principles of business or public administration, or in the field of pure science, may elect, with the approval of the adviser, work in the School of Business and Public Administration, or in the departments of mathematics and physics.

Applicants for the professional degrees must submit evidence of four months' experience in some field of engineering or activity closely related to engineering.

STATEMENT OF COURSES

Courses designated by a number with the letter f attached, thus: 100f. are given the fall term only. Those designated by a number with the letter w attached, thus: 100w, are given the winter term only.

Those designated by a number with the letters sp. attached are given during the first eight weeks of the spring-summer term only, and those marked sm. are given for the last eight weeks of the spring-summer term.

Courses numbered 200 and above are strictly graduate in character. *Arabic numerals in parenthesis indicate the number of hours credit a term.* A full description of courses will be found in the annual catalog, which may be obtained by addressing the Registrar, University of Missouri, Columbia, Missouri.

AGRICULTURAL ENGINEERING

1w. **Farm Buildings** (4) Mr. Lehmann.
2f. and w. **Farm Machinery and Farm Motors,** (3) Mr. Lehmann.
4f. **Construction Methods** (2) Mr. Lehmann.
5w. **Rural Sanitation** (2) Mr. Lehmann.
6f. **Surveying and Drainage** (2) Mr. Lehmann.
100f, 101w, 102sm. **Special Problems** (2 to 5) Mr. Lehmann.
103f. **Farm Motors** (2) Mr. Lehmann.
104w and sm. **Farm Shops** (3) Mr. Lehmann.
105s. **Agricultural Handicraft** (3) Mr. Lehmann.
106w. **Irrigation and Drainage** (2) Mr. Lehmann.
200f, w, and sm. **Thesis** (3) Mr. Lehmann.

CHEMICAL ENGINEERING

Courses in this department, not strictly engineering, may be found in the general catalog under the department of chemistry.

CIVIL ENGINEERING

Topographical Engineering

102f, w, and sp. **Elementary Surveying** (3) Mr. Williams; Mr. Miller.
103f. **Farm Surveying and Drainage** (3) Mr. Williams.
104w. **Higher Surveying** (4) Mr. Williams.
106f. **City Planning** (2) Mr. Williams.
107w. **Topographic Surveying** For students in Forestry. (3) Mr. Williams.
202f or w. **Geodesy and Precise Surveying** Mr. Williams.

Railway Engineering

111f. Railway Surveying (3) Mr. Miller.
112f. Railway Location and Construction (2) Mr. Miller.
113w. Economics of Railway Construction (2) Mr. Miller.
214w. Railway Engineering (3) Mr. Miller.
215w. Railway Yards and Terminals (2) Mr. Miller.

Structural Engineering

120f. Graphic Statics (2) Mr. Hyde.
121w. Framed Structures (5) Mr. Hyde.
124w. Mill Structures (2) Mr. Hyde.
125w. Masonry Structures (3) Mr. Spalding.
222f. Structural Design (3) Mr. Hyde.
123w. Higher Structures (3) Mr. Hyde.
226f. Concrete Structures (3) Mr. Spalding.
227f or w. Theory of Structures Mr. Hyde.

Materials of Construction

132f. Materials of Construction (2) Mr. LaRue.
133w. Testing Laboratory (1) Mr. LaRue.
134w. Road Materials (3) Mr. LaRue.
136w. Cement and Concrete Construction (1) Mr. LaRue.

Hydraulic Engineering

140f or w. Hydraulics (3) Mr. Rodhouse.
141f. Water Power (3) Mr. Rodhouse.
142w. Water Supply (2) Mr. Rodhouse.
243f. Irrigation and Drainage (2) Mr. Rodhouse.
244w. Rivers and Canals (2) Mr. Rodhouse.

Municipal Engineering

151f. Roads and Pavements (2) Mr. Spalding.
152f. Sanitary Engineering (2) Mr. McCaustland.
155w. Highway Engineering (2) Mr. Spalding.
256f. Highway Design (2) Mr. Spalding.
157w. Sanitary Design (2) Mr. McCaustland.
159f. Country Roads (1) Mr. Spalding.
257f or w. Sanitary Engineering Mr. McCaustland.

General

291w. Specifications and Contracts (1) Mr. Spalding.
299w. Thesis (1) fall term; (2) winter term.

ELECTRICAL ENGINEERING

101f, 102w. Electrical Machinery (4) Mr. Weinbach; Mr. Savant.
103f. Advanced Direct Current Machinery (3) Mr. Lanier; Mr. Savant.
110f. Advanced Alternating Currents (3) Mr. Weinbach; Mr. Savant.
111w. Advanced A. C. Machinery (4) Mr. Lanier; Mr. Savant.

120w. Problems in Direct Current Design (2) Mr. Lanier.
131w. Electric Motors (2) Mr. Weinbach.
132f. Storage Battery Engineering (2) Mr. Weinbach.
133f. Illumination (2) Mr. Savant.
134w. Telephony (2) Mr. Savant.
143f. Electrical Processes (2) Mr. Weinbach (Not offered 1919-1920.)
221f. Problems in Alternating Current Design (2) Mr. Lanier.
230f. Generation and Distribution (3) Mr. Weinbach.
240w. Central Station Design (2) Mr. Lanier.
241w. Electric Railway Engineering (2) Mr. Weinbach.
242w. Transmission (3) Mr. Weinbach.
244w. Analysis of Design Problems (2) Mr. Lanier.
280w. Application of Mathematics to Electrical Engineering (2) Mr. Weinbach.
290. Research.
298f, 299w. Thesis (1) fall term; (2) winter term.

MECHANICAL ENGINEERING

101f. Machine Design, A (3) Mr. Hibbard.
102f. Technology of Materials (2) Mr. Hibbard.
103w. Machine Design, B (3) Mr. ———
104f. Machine Design, C (2) Mr. Hibbard.

Industrial Engineering

111f. Management Engineering (3) Mr. Hibbard.
211w. Shopwork Engineering (2) Mr. Hibbard.

Testing and Experimental Engineering

121f, 122w. Mechanical Laboratory, A (2) Mr. ———
123f. Mechanical Laboratory, B (2) Mr. ———
221f or w. Special Mechanical Laboratory.

Power Engineering

131f and w. Heat Machinery, A (3) Mr. ———
132f, 133w. Heat Machinery, B (3) Mr. Wharton.
134f. Steam Power Plants (4) Mr. Hibbard.
135f. Steam Turbines (2) Mr. Wharton.
231w. Applied Thermodynamics (3) Mr. Wharton.
234f and w. Gas Engineering (2) Mr. Wharton.

Power Applications

151f. Heating and Ventilation (3) Mr. ———
154f. Refrigeration, A (3) Mr. Wharton.
241w. Refrigeration, B Mr. Wharton.

261w. **Railway Mechanical Engineering** (2) Mr. Hibbard.

The student may elect work in this course along the lines of Railway Shops, Car Design, Locomotive Design, or Locomotive Operation.

General

171w. **Seminary** (1) Mr. Hibbard.

MECHANICS

101f and w. **Elementary Mechanics** (2) Mr. Defoe.
103f and w. **Mechanics of Engineering** (4) Mr. Defoe.
112f and w. **Advanced Mechanics** (3) Mr. Defoe.
205f and w. **Elasticity** (3) Mr. Defoe.
209f or w. **Hydrodynamics** Mr. Defoe.

MANUAL ARTS

1f and w. **Woodwork** (2) Mr. Griffith; Mr. Cox.
2f and w. **Metalwork** (2) Mr. McCreery; Mr. Allton.
3f and w. **Pattern Making** (2) Mr. Griffith.
4f and w. **Machine Work.** (4) Mr. Schneitter.
5f. **Tools and Material** (1) Mr. Griffith.
6f and w. **Wood Turning** (1) Mr. Cox.
133w. **Advanced Molding and Foundry Practice** (3).
134f. **Advanced Pattern Making** (3).
135f. **Advanced Forge Work** (3).
136f or w. **Advanced Machine Work** (3) Mr. Schneitter.

MECHANICAL DRAWING

1f or w or sp. **Mechanical Drawing** (2) Mr. Newton.
2f or w or sp. **Descriptive Geometry** (2) Mr. Newton; Mr. Miller.
3f or w or sp. **Machine Drawing** (2) Mr. Newton.
141f or w. **Advanced Machine Drafting** (2) Mr. Newton.

OTHER COURSES

The following courses offered in the College of Arts and Science are of particular interest to students in the School of Engineering:

Astronomy. 1f or w, *descriptive astronomy;* 103f, *geodetic astronomy.*

Economics. 1f or w, *general economics;* 110f or w, *problems of labor;* 117f or w, *accounting;* 233f or w, *valuation of public utilities.*

Geology. 1f or w, *physical geology;* 4w, *rocks and minerals;* 100f, *economic geology;* 107f, *field geology.*

Mathematics. 120f and w, *differential equations and their applications.*

Physics. 104f, *electrical measurements;* 110w, *electricity, and magnetism;* 207, *theory of electricity and magnetism;* 112f, *heat;* 206; *theory of heat;* 221w, *electrical waves.*

GRADUATE WORK IN ENGINEERING

Graduates of the School of Engineering holding professional degrees (C.E., M.E., E.E., Ch.E.) will be admitted to candidacy for the degree of Doctor of Philosophy (Ph.D.) in the Graduate School upon the completion of a minimum of four terms of additional work.

Graduates of other schools of engineering in good standing who have completed five years of university work will be admitted on the same basis. A minimum of six terms of graduate work will be required of all graduates of engineering schools who have completed only eight terms of university work.

The faculty of the Graduate School reserves the right to pass on the qualifications of all candidates.

The graduate student is expected to devote the greater part of his time to research work. A part of the time may be given to some of the advanced courses in engineering, or other university courses allied to the main subject of study.

The work of each candidate is under the supervision of a special committee of the faculty, whose function is to advise the student in regard to his course of study and the subject of his research.

The usual work consists of the investigation of some engineering problem of practical or scientific importance. In this the student is thrown largely upon his own resources, and must show originality and capability of accurate scientific thinking. The results of the researches are to be embodied in a dissertation which shall give evidence of the merit of the work and the ability of the student. The regulations governing the degree of Doctor of Philosophy are given in the annual catalog.

The equipment and funds of the Engineering Experiment Station are available for experimental research, provided the subjects being investigated are of such practical importance as to conform to the general purpose for which the experiment station was established.

A limited number of research assistants in the Engineering Experiment Station are appointed each year, and, under suitable conditions, work carried on by these assistants may count toward the Doctor's degree. This makes the research assistantship equivalent to a graduate fellowship, enabling the candidate thus appointed to work toward his degree and at the same time earn his expenses during a part of the time.

For further information regarding graduate work, address DEAN OF THE GRADUATE FACULTY, UNIVERSITY, OF MISSOURI, COLUMBIA, MISSOURI.

OFFICERS OF INSTRUCTION AND ADMINISTRATION

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Guy Doric Newton, B. S. in M. E., M. E.,
Assistant Professor of Mechanical Drawing and Descriptive Geometry.
Dom Peter Savant, B. S. in E. E., M. S., E. E.,
Instructor in Electrical Engineering.

THE ENGINEERING EXPERIMENT STATION

OFFICERS OF THE STATION

ALBERT ROSS HILL, Ph. D., LL. D., *President of the University.*
ELMER JAMES McCAUSTLAND, C. E., M. C. E., *Dean of the Faculty of Engineering, Director of the Engineering Experiment Station.*

The Engineering Experiment Station of the University of Missouri was established by order of the Board of Curators, July 1, 1909.

The object of the station is to be of service to the people of the State of Missouri:

First, by investigating such problems in engineering lines as appear to be of the most direct and immediate benefit and publishing these studies and information in the form of bulletins.

Second, by research of importance to the manufacturing and industrial interests of the state and to engineers.

The staff of the station consists at present of a director and four research assistants together with a number of teachers who have undertaken research under the direction of the station.

Suggestions as to problems to be investigated, and inquiries will be welcomed.

Bulletins have been published as follows:

Vol. 1, No. 1, *Acetylene for Lighting Country Homes,* by J. D. Bowles, research assistant, 1909-10.

Vol. 1, No. 2, *Water Supply for Country Homes,* by K. A. McVey, research assistant, 1909-10.

Vol. 1, No. 3, *Sanitation and Sewage Disposal for Country Homes,* by W. C. Davidson.

Vol. 2, No. 1, *The Heating Value and Proximate Analysis of Missouri Coals,* by C. W. Marx and Paul Schweitzer. (a reprint.)

Vol. 2, No. 2, *Friction and Lubrication Testing Apparatus,* by Alan E. Flowers.

Vol. 2, No. 3, *Tests of Road Materials of Missouri,* by W. S. Williams and Warren Roberts.

Vol. 3, No. 1, *The Use of Metal Conductors to Protect Buildings From Lightning,* by E. W. Kellogg.

Vol. 3, No. 2, *Firing Tests on Missouri Coal,* by H. N. Sharp, research assistant, 1911-12.

Vol. 3, No. 3, *A Report on Steam Boiler Trials Under Operating Conditions,* by A. L. Westcott.

Vol. 4, No. 1, *Economics of Rural Distribution of Electric Power,* by L. E. Hildebrand, research assistant, 1912-13.

Vol. 4, No. 2, *Comparative Tests of Cylinder Oils,* by M. P. Weinbach.

Vol. 4, No. 3, *Artesian Waters of Missouri,* by A. W. McCoy, research assistant, 1912-13.

Vol. 4, No. 4, *Friction Tests of Lubricating Grease and Oils,* by A. L. Westcott.

Engineering Experiment Station Series 14, *A Study of the Effect of Heat on Missouri Granites,* by W. A. Tarr and L. M. Neuman, research assistant, 1913-14.

Engineering Experiment Station Series 15, *A Preliminary Study Relating to the Water Resources of Missouri,* by T. J. Rodhouse.

Engineering Experiment Station Series 16, *The Economics of Electric Cooking,* by P. W. Gumaer.

Engineering Experiment Station Series 17, *Earth Roads and the Oiling of Roads,* by H. A. LaRue.

Engineering Experiment Station Series 18, *Heat Transmission Thru Boiler Tubes,* by E. A. Fessenden and J. W. Haney, research assistant, 1915-16.

Engineering Experiment Station Series 19, *Geology of Missouri,* by E. B. Branson.

The following studies are now in progress:

- Coal testing
- Deep wells and deep well pumping
- Artificial illumination
- Effect of size and quality of sand upon cement mortar
- Missouri clays
- Water power in Missouri
- Metallic alloys
- Available road materials in Missouri

Besides these a number of detailed studies of materials and processes and investigations of Missouri's resources are in progress.

A standardizing laboratory has been established and the apparatus is now available for tests of electric, gas, and water meters of practically all types.

The State Highway Department is making use of the laboratories of the Engineering Experiment Station for the testing of road materials used in the state.

Any resident of the state may, on request, obtain the bulletins as issued. Those who are particularly interested may have their names placed on the regular mailing list. Address Director, Engineering Experiment Station, University of Missouri, Columbia, Missouri.

INFORMATION ABOUT THE UNIVERSITY

The fundamental aim of the University of Missouri is the development of the highest and most efficient type of citizen. For the purpost of accomplishing its aim, the University furnishes ample facilities for liberal education and for thoro professional training. The University is a part of the public educational system of the state.

ORGANIZATION

The work of the University is now carried on in the following divisions:

College of Arts and Science
College of Agriculture
School of Education
School of Medicine
School of Engineering
School of Mines and Metallurgy
School of Journalism
School of Business and Public Administration
Graduate School
Extension Division

All of these divisions are at Columbia, with the exception of the School of Mines and Metallurgy, which is at Rolla. In addition, emphasis is given particular lines of work by the establishment of minor divisions, the chief of which are the Agricultural Experiment Station, the Engineering Experiment Station, and the Missouri State Military School.

LOCATION

The University of Missouri is at Columbia, half way between St. Louis and Kansas City, near the center of the state. It is reached by the Wabash and by the Missouri, Kansas, and Texas railways. Columbia is a progressive and prosperous city, having doubled its population in the last few years.

Columbia may be characterized as a city of schools, homes, and churches, with enough of industrialism to make it efficient. It offers the conveniences of a larger city without the distractions. The student is a predominant factor in Columbia.

EQUIPMENT

The University grounds cover more than 800 acres. The main divisions are in the west campus, the east campus, the athletic fields, and the University farm.

The following University buildings are at Columbia: Academic Hall; new Library Building; Laws Observatory, separate buildings for chemistry, physics, biology, business and public administration and geology, engineering, manual arts and law; two power houses; Medical Laboratory Building; Parker Memorial Hospital; Agriculture Building; Horticulture Building; Schweitzer Hall, for agricultural chemistry; green houses; Live Stock Judging, Poultry, Dairy, Farm Machinery, and Veterinary buildings; the University farm barns and buildings; Switzler Hall, for the School of Journalism; Gordon Hotel Building for home economics; Lathrop Hall, dormitory for men; Read Hall, dormitory for women; Rothwell Gymnasium; the houses for the President of the University and the Dean of the Faculty of Agriculture; the High School and the Elementary School buildings, used for practice schools in the School of Education.

FOR FURTHER INFORMATION

For further information concerning the School of Engineering, address

E. J. McCaustland,
Dean, Faculty of Engineering,
University of Missouri,
Columbia, Missouri.

Full information regarding the University is given in the catalog, which will be sent on request without charge. For this or special bulletins of the College of Arts and Science, College of Agriculture, School of Education, School of Law, School of Medicine, School of Engineering, School of Journalism, School of Business and Public Administration, Extension Division, and the Graduate School, write to

The Registrar,
University of Missouri,
Columbia, Missouri.

UNIVERSITY CALENDAR

Session 1919-20

1919

FALL TERM

Aug. 26, 27, 28	Tuesday, Wednesday, Thursday, entrance examinations	
Aug. 29, 30	Friday, Saturday, registration	
Aug. 30, 7:30 p. m.	Saturday, opening convocation	
Sept. 1, 8 a. m.	Monday, class work begins	
Oct. 27, 8 a. m.	Monday, to	First term, two-year winter course in agriculture
Dec. 20, noon	Saturday	
Nov 27	Thursday, Thanksgiving Day, holiday	
Dec. 20, noon	Saturday, fall term ends Christmas Holidays	

WINTER TERM

Dec. 30	Tuesday, registration	
Dec. 30, 7:30 p. m.	Tuesday, opening convocation	
Dec. 31, 8 a. m.	Wednesday, class work begins	
Dec. 31, 8 a. m.	Wednesday, to	Second term, two-year winter course in agriculture
1920		
Feb. 27, 4 p. m.	Friday	
Feb. 22	Sunday, Washington's Birthday	
April 18	Sunday, Baccalaureate Address	
April 20, 4 p. m.	Tuesday, winter term ends	
April 22	Thursday, Commencement Day	

SPRING-SUMMER TERM

April 24	Saturday, registration
April 24, 7:30 p. m.	Saturday, opening convocation
April 26, 8 a. m.	Monday, class work begins
June 19	Saturday, first half of term ends
June 21	Monday, second half of term begins
Aug. 14, noon	Saturday, spring-summer term ends

THE
UNIVERSITY OF MISSOURI
BULLETIN

GENERAL SERIES

EDITED BY
VAUGHN BRYANT
University Publisher

The General Series of the University of Missouri Bulletin consists of the general catalog and the announcements of the various colleges and schools which compose the University. These announcements will be sent free upon request to the Registrar, University of Missouri, Columbia, Missouri.

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THE UNIVERSITY OF MISSOURI BULLETIN
VOLUME 21, NUMBER 12

GENERAL SERIES
1920, No. 6.

SCHOOL OF ENGINEERING

ANNOUNCEMENT 1920-21

ISSUED THREE TIMES MONTHLY; ENTERED AS SECOND-CLASS MATTER AT POSTOFFICE AT COLUMBIA, MISSOURI—4,500
APRIL, 1920

THE UNIVERSITY OF MISSOURI BULLETIN
VOLUME 21, NUMBER 12

GENERAL SERIES
1920, No. 6.

SCHOOL OF ENGINEERING

ANNOUNCEMENT 1920-21

MDCCCXXXIX

ISSUED THREE TIMES MONTHLY; ENTERED AS SECOND-CLASS MATTER AT POSTOFFICE AT COLUMBIA, MISSOURI—4,500
APRIL, 1920

UNIVERSITY CALENDAR

1920	*Fall Term*
August 26, 27, 28	Thursday, Friday, Saturday, entrance examinations
August 30, 31	Monday, Tuesday, registration
September 1	Wednesday, 8 a. m., class work begins
November 25	Thursday, Thanksgiving Day, holiday
December 22	Wednesday, noon, fall term ends Christmas Holidays

1920	*Winter Term*
December 31 1921 January 1	Friday, Saturday, registration
February 22	Tuesday, Washington's Birthday, holiday
April 24	Sunday, Baccalaureate Address
April 27	Wednesday, Commencement Day

1921	*Spring-Summer Term*
April 28	Thursday, registration
April 29	Friday, 8 a. m., class work begins
June 21	Tuesday, first half of term ends
June 22	Wednesday, second half of term begins
July 4	Monday, the Fourth of July, holiday
August 17	Wednesday, spring-summer term ends

FOREWORD—THE PROFESSION

OPPORTUNITIES FOR ENGINEERING GRADUATES

The activities of the recent war served to emphasize the great need for a more general extension of technical training. Such training has a value outside the narrow limits of professional application and it has fully demonstrated its value in the field of general business and public affairs. Special plans are in process of formulation that will enable underclassmen in the School of Engineering to come more closely in contact with business and industrial affairs. It is hoped that this contact will serve to motivate the work of the student and to assist him in giving direction to his preparation.

The consensus of engineering judgment thruout the country favors an increasing attendance at the technical schools in order to prepare a large number of trained men to meet the pressing needs of the near future.

The field of engineering and technical training is especially commended to those who may be contemplating a preparation for their life work, and who feel that their ability to serve their country to the best advantage may lie along lines developed by technical training.

The War Department is seeking to make use of the advantages of engineering training in the universities of the country, and the Chief of Engineers of the United States Army has reported favorably upon the School of Engineering of the University of Missouri as a place for the organization of an engineering unit in the Reserve Officers Training Corps. The outlook in the field of engineering is especially encouraging to young men of character, ability, and willingness to work.

THE MODERN ENGINEER—RELATION TO SOCIETY

About the middle of the nineteenth century the industrial development which had followed the invention of the steam engine became so highly specialized that engineers found it necessary to restrict their individual fields of practice. Previous to this period, engineering had developed out of the needs of the military and later the needs of civil organizations, thus producing two classes in the profession known respectively as military engineers and as civil engineers, with no further division into specialties. Progress in the art of engineering came thru the extension of practice rather than from a study of the fundamental laws of science underlying the art. The modern point of view, however, emphasizes the value of a thoro knowledge of the laws of science which serve as the foundation upon which the practice of the profession may be developed.

The study of present social conditions in the civilized world reveals the fact that the advances of the last one hundred and fifty years are founded largely on the work of the engineer, whose application of the discoveries of modern science has brought about conditions leading to improved health, comfort and the conveniences of living. The economic history of the past century is also closely interwoven with, and to a large degree dependent upon, the inventions and mechanical developments of the engineer.

These facts give emphasis to the statement that there are excellent opportunities in modern life and industry for able and well trained engineers. The financial rewards are not usually as great as may be gained in commercial life altho there is a distinct tendency at the present time to value more highly and to increase the compensation for the services of engineers. However, the true engineer has an enthusiasm for his work which makes *opportunity for service* more attractive to him than the opportunity for personal gain.

Engineers find employment in the service of various corporations, as designing engineers for structural work or for machines, and finally after considerable experience, they may prosper as independent consulting engineers. Many abandon technical practice altogether and enter administrative or managerial positions or seek service in the business organizations of industrial enterprises.

The development of governmental control of public utilities opens a way for the employment of many engineers who may be called upon to fix rates and enforce standards of quality, quantity and service; their judgment may be needed also to authorize or forbid bond issues, depending upon the financial and physical condition of the corporation. In the exercise of these and similar functions, the engineer should be well equipped with technical knowledge, and he should also have some understanding and appreciation of the legal, economic, commercial, social and ethical questions involved in such problems as valuation and rate fixing.

The rapid growth of public ownership of utilities such as the municipal ownership of electric light and power, water, gas and transportation plants, opens the way for further work for the engineer. The earlier type of municipal engineer whose practice was largely confined to planning and overseeing the construction and maintenance of streets and pavements, sewers, parks and water mains, was best trained as a civil engineer. For municipalities owning and operating their public utilities such as water supply, power and light plants, etc., the office of city engineer may well be filled by a mechanical or electrical engineer.

The development of engineering into specialties has become a characteristic of modern practice and schools recognize this in the outlining of curricula. Some of these special fields are briefly outlined below.

DIVISION INTO SPECIALTIES

Agricultural Engineering

The most recent subdivision of engineering has to do with the applications of the art to agricultural problems such as drainage, irrigation, water supply and sewerage for the farm, design of farm machinery, etc. The field open to agricultural engineers ranges all the way from strictly engineering work to the general management of large farm operations. Many drainage and irrigation projects intended to develop agricultural resources have failed because attention was concentrated upon the engineering features and little attention given to agricultural phases of the problem until the work was practically completed.

Training in agricultural engineering contemplates a thoro understanding of the elementary principles underlying both agriculture and engineering.

Chemical Engineering

Engineers with special training in chemistry, who devote themselves to the development of the various chemical industries, are known as chemical engineers. Much of recent progress is due to the discovery and development of new materials and compounds with characteristics that make them valuable in the arts. A great part of the research being carried on for commercial purposes lies along these lines. A man who has had a thoro training in chemistry, and who combines with his knowledge of chemistry an insight into physical and mechanical problems and an appreciation of the commercial significance of his work, is best qualified to make himself valuable in investigation of this kind. Not only the discovery of new products, but the maintenance of a standard of quality in manufactured materials, demands the labor of men who have a knowledge of chemistry.

This field of work is rapidly becoming very large because of the many and varied industries which have been and are being developed.

Civil Engineering

The term civil engineering is still often used in its original sense as covering all engineering not military, but commonly it is limited to those fields of practice not included in the other branches.

In the number of special fields of work included, it is the broadest branch of engineering practice. It comprises:

Surveying, which in simple forms is used by all civil engineers, but which when applied in geodetic and topographic work may constitute a distinct field of practice.

Hydraulic engineering, which includes the design and construction of harbors and docks, river improvements, canals, irrigation works, drainage and flood prevention, and water power projects.

Sanitary engineering, covering all works designed to protect the public health, such as water supply and water purification, sewerage and sewage disposal, and the disposal of garbage and refuse.

Highway engineering, in which may be included both the maintenance and improvement of country roads and the construction and maintenance of city streets and pavements.

Railway engineering, which deals with the design, construction, and maintenance of all works required for steam and electric railways.

Structural engineering, which is concerned with the design and construction of bridges and of the structural features of large buildings that carry heavy loads, masonry and concrete structures, and heavy foundations.

General construction, under which head may be included the execution of large works of construction, and the transportation and handling of heavy materials.

Electrical Engineering

Engineers who are concerned mainly with the generation, transmission, or utilization of electrical energy are known as electrical engineers.

The last few years have seen a great increase in the applications of electricity, and the field of its usefulness is constantly widening. The special fields of most importance into which electrical engineering is divided are:

The design and construction of generators, motors, and other apparatus required in the generation, distribution, and utilization of electric power.

The design, construction, and operation of plants for generating electric power and lines for its transmission.

The application of electricity to industrial power.

The building and operation of electric railways.

The utilization of electric energy for lighting purposes.

The design, construction, and operation of telephone and telegraph systems.

The application of electricity in the various chemical industries.

Mechanical Engineering

The term mechanical engineering is usually employed to designate the work of those engineers who have to do primarily with steam or other engines, machine tools, mill work, and moving machinery in general. The lines of work included in the practice of a mechanical engineer may be:

Power engineering, which consists in the design, construction and operation of machines and plants for the generation of power. These may include steam, gas, oil, or other engines, with all the auxiliary appliances necessary to their operation, as well as the various methods of power distribution.

Design of plants and machinery for the utilization of power, requiring the study of special processes for which machinery may be required, and the adaptation of machines and arrangement of plants for purposes of economical production.

Shop management, dealing with the control and management of shops in the operation of manufacturing plants.

Gas engineering, covering the production, distribution, and utilization of gas for light, heat, and power purposes.

Railway mechanical engineering, consisting of the design, construction, and operation of rolling stock and other machinery, and of the shops required in the operation of railways.

THE SCHOOL OF ENGINEERING

BUILDINGS AND EQUIPMENT

The departments of electrical and mechanical engineering of the University of Missouri at Columbia occupy the main Engineering Building and the department of civil engineering occupies a part of Switzler Hall. The work in chemistry required of students in chemical engineering is given in the Chemistry Building and the specialized work in agricultural engineering is offered in the Farm Machinery Building.

The main engineering laboratories are in the Engineering Annex in the rear of the Engineering Building. A substantial addition to the Engineering Annex is now being used for the expansion of the mechanical engineering laboratory and for the development of a hydraulic laboratory. Shop work is conducted in a building recently erected for the purpose.

Agricultural Engineering. This laboratory contains a large assortment of the best modern machinery, including one or more samples of the principal field and power machines. A line shaft driven by an electric motor is available for demonstrating these machines.

For instruction in gas engines and tractors, the laboratory is equipped with ten stationary and portable gasoline and oil engines and samples of the latest type of tractors with suitable equipment for testing them. Lighting units are provided for work on farm lighting systems. Drafting tables are provided to accommodate the men designing farm buildings.

The equipment for concrete work includes a complete set of concreting tools, molds for building blocks, forms for fence posts, water troughs, and tanks and tile machines, with small apparatus for testing cement and aggregates. A level and transit with complete set of tools are provided for tile drainage work.

CHEMICAL ENGINEERING. In addition to the laboratories in general chemistry, there are separate laboratories for the other fundamental courses in chemistry required in the chemical engineering curriculum. The general analytical laboratory offers facilities for work in qualitative and quantitative analysis. Special work in the technical analysis of fuels, water, gas, and commercial products is given in smaller laboratories equipped especially for these lines of work. Two laboratories are available for general work in organic chemistry, and more advanced work along organic lines is provided for in a furnace room and a laboratory for the preparation of organic compounds. The laboratory in physical chemistry is equipped for work in electro-chemistry and measurements in radioactivity. Advanced students have an opportunity to pursue work in metallography. The electrical laboratories in the Engineering Building offer facilities for work in electro-plating, storage battery engineering, and electrical processes.

CIVIL ENGINEERING. The laboratory for testing materials is in charge of the department of civil engineering. The equipment includes several vertical testing machines with all necessary accessories for tension, compression, and transverse tests on the ordinary engineering materials, iron, steel, cement, concrete, brick; a beam-testing machine; a torsion machine; impact and abrasion machines. There is also complete equipment for all the standard tests upon hydraulic cement.

The road materials laboratory contains the necessary machine for making complete tests upon stone for road purposes, a standard rattler for paving brick tests, and the apparatus required in investigating bituminous road materials.

There is a good collection of surveying instruments, including the instruments used in ordinary field practice and those necessary for precise surveying and geodetic work.

Stream gages, with a dam and weirs on streams near Columbia, afford opportunity for field study of water supply problems, while practice in hydrographic surveying and stream measurements is obtained by a trip to a river in the neighborhood.

HYDRAULIC LABORATORY. A new hydraulic laboratory has been equipped recently for the study of problems where large quantities of flowing water are needed. Two large size direct-connected electric motor-driven centrifugal pumps have been installed. These pumps will supply water for investigations relating to the flow of water in flumes, large pipes, and conduits; to the discharge over dams and weirs, thru racks, sluices, and submerged orifices; and to other features encountered in the water power and water supply developments.

Apparatus has been installed for the study of the flow of water thru pipes, fire hose and nozzles, and the effect of valves and bends; for the study of the flow of water thru sand filters, and of ground-water flow in soil drainage; and for the testing of pumping machinery and water wheels.

Full equipment for the accurate measurement of quantities, velocities, and pressures, both in open and closed channels, is available, and includes the latest types of Pitot tubes, automatic self-recording gages and water meters.

ELECTRICAL ENGINEERING. The electrical engineering laboratory contains direct and alternating current generators and motors of the common types met with in practice and all the instruments necessary to make complete tests of their operation. Besides several low-ratio transformers used in routine exercise, the laboratory has a 10,000-volt transformer for testing dielectric strengths, one of 40,000-volts and one 10 KVA of 100,000 volts for high tension experiments. A set of Edison cells and one of chloride cells are available for experiments on storage batteries.

A low voltage motor-generator set is provided for general electrochemical processes such as electro-plating with gold, silver, nickel, and copper. One large and several small electric furnaces are used for demonstrations of the electric processes involved in the production of carborundum, graphite, emery, calcium carbide, ferroalloys.

The telephone equipment comprises a demonstration board showing all the apparatus and operations involved in a connection thru two offices. For experiments in telephone transmission, there is a high frequency generator and an artificial line, which is electrically equivalent to fifty miles of underground wire.

The laboratory also has a quadruplex telegraph set.

MECHANICAL ENGINEERING. The mechanical engineering laboratory contains several different types of steam engines, a small steam turbine with a superheater, condensers, gas engines, reciprocating and centrifugal pumps, a number of fans, blowers, and heating coils for work on ventilation and heating, and a variety of other machinery. Much attention is paid to the study of fuels of all kinds. Complete standard apparatus for determining the analysis and calorific value of coals and gases is provided. The laboratory is supplied with the usual equipment of indicators, gases, water and gas meters, scales, and other necessary accessories.

The central power plant of the University is used for conducting boiler tests under actual operating conditions. Considerable attention is given to the study of refrigeration. Several small ice and cold storage plants belonging to the University are available for tests. A local privately owned plant is also sometimes used.

A high grade lathe, completely equipped for use in connection with courses in shop efficiency, has been purchased recently. It will be used to make production tests to determine the proper kinds of tools and the best cutting speeds to use in making machine parts.

Library. The engineering library in the Engineering Building has 5,000 standard engineering books. These have been carefully selected and include the works of all the best American and English engineering authors. About 100 periodicals are regularly received, together with publications recording the transactions of the more important engineering societies.

Engineering students are permitted free access to the library shelves for reference and are encouraged to draw books for outside reading.

The general library of the University and the library of the State Historical Society, together containing about 250,000 books and pamphlets, are open to all students in the University.

STUDENT ACTIVITIES

Engineering Societies

The Engineers' Club is made up of students from all classes and, as its main function, affords opportunities for close acquaintance among the students in the school.

Branches of two national engineering societies, the American Institute of Electrical Engineers and the American Society of Mechanical Engineers, have been established for several years. Meetings of each are held semi-monthly for the discussion of current engineering problems, usually drawn from the publications of the national societies received regularly by the members of the branches. Practically all of the upperclassmen in electrical engineering and mechanical engineering are active members of one or the other of the branches, and a great deal of interest is taken in the meetings. These societies are strongly encouraged because of the benefits to be derived from practice in preparing and delivering papers before a critical audience and for the acquaintance with the activities of the prominent engineers composing the national societies.

During 1913, the Civil Engineers' Society, working along lines similar to those followed by the branches discussed above, was organized. This society is not affiliated with a national society.

In 1919 a chapter of the American Association of Engineers was given a charter, and the organization now has about 125 members.

Athletics

Students in all divisions of the University are encouraged to take part in athletics in one form or another. Class teams and Varsity teams are maintained in football, baseball, basketball, tennis and track. These are all carefully supervised and are under the direction of the experienced coaches and trainers.

Rothwell Gymnasium is well lighted and well ventilated and equipped with the usual apparatus. Bathing, locker, and dressing facilities are provided in the basement.

Rollins Field, named in recognition of the generosity of members of the Rollins family, is just west of Rothwell Gymnasium. It contains a quarter-mile cinder track, 220-yard straightaway, grounds for field athletics, a gridiron for football, and a baseball field. All intercollegiate contests are held here.

Concrete bleachers which seat 4,250 persons have been constructed. A new concrete fence with ornamental gate partly surrounds Rollins Field.

Tennis courts, basketball courts, baseball, football, and soccer fields for all students are situated near the gymnasium.

MILITARY AND PHYSICAL TRAINING

REQUIRED. All physically fit men students in the University are required to take four terms of Military Science and Tactics and Physical Training during their freshman and sophomore years.

ADVANCED COURSE. Any student who has completed two academic years in the course, and who has been selected for further military training, may be enrolled for an advanced course of four terms, upon executing an agreement in writing. *Students taking the advanced courses* (5 *hours a week*) *will be paid commutation of subsistence by the United States.* Upon completion of the advanced course, they are eligible for appointment in the Officers' Reserve Corps, and as temporary second lieutenants in the Regular Army. Eight hours' credit toward graduation is allowed for this work.

FEES AND EXPENSES

TUITION. Tuition is free in all divisions of the University to students who are residents of the state. Non-residents of the state are required to pay a tuition fee of $10 a term in all divisons of the University, except in the Graduate School.

LIBRARY, HOSPITAL, AND INCIDENTAL FEE. All students in the University except those enrolled in the short winter courses in agriculture, and except those specially exempt by law or by rule of the Curators,* are required to pay a library, hospital, and incidental fee of $15 for each registration.

LABORATORY DEPOSITS. Each student entering a laboratory is required to make a deposit of $5, unless a different amount be fixed by the President of the University and the director of the laboratory. From the amount deposited there is deducted a fixed charge (in no case less than $1, for each individual laboratory course), and also all charges for materials used or for damages to or loss of University property. If the deposit is insufficient to cover all such charges the student is required to make an additional deposit or deposits. When damage or loss is sustained by a laboratory, it is assessed against the deposits of students using the laboratory at the time of the damage or loss, unless such damage or loss be traced to some individual student or students. The remainder of any deposit, after payment of all charges, is refunded to the student at the end of his laboratory course in any session, provided it be called for within twenty days after the close of the session. If not so called for, the amount will be credited to the laboratory in which the deposit was made. For details consult the annual catalog. All fees and deposits must be paid in advance.

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*See the annual catalog.

Books and Instruments. The cost of books varies considerably depending upon the courses being taken each year; a fair average is from $20 to $25 a term. A good set of drawing instruments is required in the first year's work in mechanical drawing and is used thruout the course. This costs from $15 to $25, depending upon the quality.

Room Rent and Board. Rooms may be rented in Lathrop Hall, the University dormitory for men, at from $14 to $20 for each student for a term of sixteen weeks. Two students occupy each room and the rent depends upon the location of the room.

For rooms in private houses, from $10 to $16 a month is charged the average being about $13. This is usually shared by two students.

The Commons, run under the direction of the University, consists of a cafeteria in Lathrop Hall. Meals are served at cost.

Board in private boarding houses usually costs from $5.50 to $7.50 a week. Private boarding clubs are formed in which the average cost is somewhat less.

Total Expenses. The table below is intended to give an idea as to the probable expenses per term of a student in the University.

Fees	$25
Board	95
Rent	25
Laundry	15
Books and stationery	15
Miscellaneous	50
Total	$225

Clothing and railroad fares are not included in this table. The actual expenditures will depend largely upon the tastes and inclinations of the individual stulent.

There are many opportunities for a student to earn money to pay part or all of his expenses at Columbia. The Y. M. C. A. conducts an employment bureau to aid students in finding work of this kind. Students who must spend part of their time in outside employment should not expect to take full work in the University and under these circumstances an additional year is often required to satisfy the requirements for graduation. Students coming to Columbia for the first time should not expect to find work at once, but must have some funds available to meet necessary expenses until employment is obtained. This may require several months. Information regarding employment may be had by addressing, Secretary, Employment Bureau, Y. M. C. A. Building, Columbia, Mo.

REQUIREMENT FOR ADMISSION

Fifteen units, the equivalent of a 4-year high school course, are required for admission as a regular student in the School of Engineering.

A unit is the equivalent of a subject pursued five periods a week for at least thirty-six weeks, four units constituting a year's work.

CURRICULA AND DEGREES

There are five curricula leading respectively to the professional degrees of Agricultural Engineer, Chemical Engineer, Civil Engineer, Electrical Engineer, and Mechanical Engineer. The requirement for a professional degree is 158 credit hours, or ten terms of college work. The work of the first two terms is the same in all curricula and is outlined in the tables which follow. The additional requirements are further tabulated and listed.

The degree of Bachelor of Science in Engineering may be given at the end of eight terms of college work for a total of 128 credit hours as shown in the following tables.

Students may obtain both the A. B. and a professional engineering degree in twelve terms. Those who can afford the additional time required are urged to take advantage of the opportunity thus afforded for general cultural training combined with an engineering education. This is made possible by—

(a) The acceptance of the following subjects (to a maximum of 20 credit hours) for the A. B. degree: mechanics (courses 101, 103 and 112); electrical machinery (electrical engineering, courses 101 and 102) 8 hours; applied thermodynamics (mechanical engineering, course 231), 3 hours; elementary surveying (civil engineering, course 102), 3 hours; woodwork (industrial arts, course 1), 2 hours; metal work (industrial arts, course 2), 2 hours; drawing (engineering drawing, courses 1 and 2), 4 hours.

(b) The waiving of certain restrictions in the choice of electives in the School of Engineering, for students having an A. B. degree.

Students desiring to take both the A. B. and a professional engineering degree should plan their work carefully from the beginning to insure that the following items are accomplished in their first eight terms:

1. The completion of all the requirements of the A. B. degree (see the annual catalog).

2. The completion of sufficient electives chosen from the subject from the School of Engineering that are accepted toward an A. B. degree (see list in paragraph (a) above) to reduce the required engineering courses remaining to be taken in the last four terms to a maximum of 60 credit hours.

Curricula meeting all these requirements are not difficult to arrange and considerable latitude may be allowed to satisfy individual needs and inclinations. To assist students in planning their work, a number of suggestive curricula are on file in the office of the dean, School of Engineering.

The courses in engineering require that students *be strong in mathematics and physics, and have the scientific spirit. Those who are not qualified in these lines are advised not to undertake work in engineering.*

For a full statement of the requirements for entrance, see the annual catalog of the University. This may be obtained by addressing the Registrar, University of Missouri, Columbia, Missouri. For special information not found in the catalog, address the Dean of the Faculty of Engineering, University of Missouri, Columbia, Mo.

AGRICULTURAL ENGINEERING

(*Administered jointly by the Dean of the Faculty of Agriculture and the Dean of the Faculty of Engineering.*)

The demand for men trained in engineering as applied to different phases of agriculture has led to the introduction of a curriculum in agricultural engineering. This curriculum emphasizes the fundamentals of engineering subjects, makes the student familiar with modern scientific agriculture and gives him a training in agricultural engineering.

The training contemplated will fit men for professional work in that line of engineering where an agricultural viewpoint is necessary, such as problems in drainage and irrigation, planning for buildings, and design of farm machinery. It will fit men for government and teaching positions, to be experts and salesmen with farm machinery manufacturers, and will prepare them to take charge of large farms where engineering applications in agriculture are important factors.

CHEMICAL ENGINEERING

The rapid development of the chemical industries and the ever increasing demand for engineers trained in the fundamental subjects have led to the introduction of courses in chemical engineering. The curriculum outlined is designed to give a broad and thoro training in general engineering subjects and in theoretical and applied chemistry. Instruction in chemistry continues thru the whole length of the curriculum. The general principles of physical science are further emphasized by extended courses in mathematics, physics, and mechanics.

The curriculum aims to implant in the students a scientific method of work. Instruction is given by means of recitations, lectures, laboratory work, and conferences. The electives enable the student to give some attention to specialization, but the prime object is to produce a broadly trained chemical engineer.

CIVIL ENGINEERING

The field covered by this curriculum is wide, embracing topographical, railway, hydraulic, structural, municipal, and highway engineering. It is the aim to give a broad general training which may later serve as a foundation for the development of any special line under the general term, civil engineering.

The curriculum has, therefore, been arranged with the purpose of providing thoro training in those fundamental sciences and principles upon which the practice of the civil engineer is based, and also, in so far as practicable, of giving instruction in the special subjects which underlie the several branches. A number of subjects are made elective, with the object of permitting the student to select his more advanced work in one of the special divisions of civil engineering.

ELECTRICAL ENGINEERING

The curriculum in electrical engineering is intended to prepare students for electrical designing, manufacturing, contracting, and for the installation and management of central and isolated electric light stations, power plants, and electric railways. It is planned to furnish insight into and appreciation of the complex problems requiring solution by electrical engineers, while giving thoro, broad training.

The technical work consists of the theory and principles of electricity and magnetism; electrical measurements; calibration of instruments; tests of all kinds; designs and construction; study of problems in the generation, transmission, distribution, and utlization of electrical energy.

Special attention is paid to alternating current phenomena.

MECHANICAL ENGINEERING

The curriculum in mechanical engineering is intended to fit young men to get the greatest advantage from the practical experience which must precede, accompany or follow such a study of the applications of the sciences in a profession; and to enable them to be of earlier and greater responsible value in connection with engineering properties—as designers, installing engineers, in testing and inspection work, in engineering salesmanship or other associated specialties, in power plant operation, in manufacturing, in efficiency improvement, and in the conception, organizing, and direction of extended mechanical industrial enterprises.

CURRICULA IN ENGINEERING 1920-21.

First year (same in all Curricula).

Subject.	Department and Course No.	Term. Fall.	Term. Winter.
Trigonometry and algebra	Math. 2f	5	
Analytic geometry	Math. 4w		5
Problems in citizenship		5	5
General inorganic chemistry	Chem. 1f or w	5 or 0	0 or 5
Drawing I	E. D. 1f or w	0 or 2	2 or 0
Woodwork	I. A. 1f or w	0 or 2	2 or 0
Military science and physical education	M. S.	2	2
		17 or 16	16 or 17

Agricultural Engineering

SECOND YEAR

Subject.	Department and Course No.	Fall.	Winter.
Calculus	Mathematics f, w	3	3
General physics	Physics 3f, 4w	5	5
Mechanics of engineering	Mechanics 1w		2
Materials of construction	C. E. 132f or w	3	
Field crops	F. C. 1f	5	
Analytical chemistry	Chem. 25w		5
Military science and physical education		2	2
		18	17

THIRD YEAR

Subject.	Department and Course No.	Fall.	Winter.
Mechanics of engineering	Mech. 101f, 102w	3	3
Electrical machinery	E. E. 101f, 102w	4	4
Drawing II	E. D. 2f or w	2	
Metal work	I. A. 2f or w		2
Elementary surveying	C. E. 102f	3	
Farm machinery and farm motors	Ag. E. 1f or w	3	
Soil physics	Soils 1f or w		5
Technical writing	English		2
		15	16

Agricultural Engineering

FOURTH YEAR

Subject	Department and Course No.	Term. Fall.	Term. Winter.
Hydraulics	C. E. 140f or w	3	
Roads and pavements	C. E. 151f	2	
Irrigation and drainage	C. E. 243f	2	
Heat machinery, A	M. E. 131f or w		3
Farm buildings	Ag. E. 1w		4
Rural Sanitation	Ag. E. 5w		2
Advanced farm motors	Ag. E. 103f	2	
Soil Management	Soils 2w		3
Types and classes of live stock	A. H. 1w	3	
General economics	Econ. 1f	3	
Elective			2
		15	14

Chemical Engineering

SECOND YEAR

Subject	Department and Course No.	Fall.	Winter.
Calculus	Math. f, w	3	3
General physics	Phys. 3f, 4w	5	5
Mechanics of engineering	Mech. 1w		2
Materials of construction	C. E. 132f or w	3	
Drawing II, III	E. D. 2f, 3w	2	2
Inorganic chemistry	Chem. 2f or w	3	
Qualitative analysis	Chem. 27f or w		3
Military science and physical education		2	2
		18	17

THIRD YEAR

Subject	Department and Course No.	Fall.	Winter.
Mechanics of engineering	Mech. 101f, 102w	3	3
Electrical machinery	E. E. 101f, 102w	4	4
Advanced calculus	Math.		4
Elementary surveying	C. E. 102f or w	3	
Organic chemistry	Chem. 110w		5
Quantitative chemical analysis	Chem. 121f	5	
		15	16

FOURTH YEAR

Subject	Department and Course No.	Fall.	Winter.
Hydraulics	C. E. 140f or w		3
Graphic statics	C. E. 120f	2	
Heat machinery, A	M. E. 131f or w		3
Machine design, A	A. E. 103f or w		3
Metal work	I. A. 2f or w	2	
Physical chemistry	Chem. 131f	5	
General economics	Econ. 1f	3	
Technical writing	English		2
Elective		3	3
		15	14

Civil Engineering

SECOND YEAR

Subject	Department and Course No.	Term.	
		Fall.	Winter.
Calculus	Math. f, w	3	3
General physics	Phys. 3f, 4w	5	5
Mechanics of engineering	Mech. 1w		2
Materials of construction	C. E. 132f or w		3
Elementary surveying	C. E. 102f or w	3	
Drawing II, III	E. D. 2f, 3w	2	2
Metal work	I. A. 2f or w	2	
Military science and physical education		2	2
		17	17

THIRD YEAR

Mechanics of engineering	Mech. 101f, 102w	3	3
Electrical machinery	E. E. 101f, 102w	4	4
Advanced calculus	Math. w		4
Heat machinery, A	M. E. 131f or w	3	
Higher surveying	C. E. 104w		4
General economics	Econ. 1f	3	
Graphic statics	C. E. 120f	2	
		15	15

FOURTH YEAR

Hydraulics	C. E. 140f or w	3	
Railway surveying	C. E. 111f	3	
Stresses	C. E. 121f	3	
Framed structures	C. E. 122w		2
Masonry structures	C. E. 125w		3
Sanitary engineering	C. E. 152f	2	
Roads and pavements	C. E. 151f	2	
Machine design, A	M. E. 103f or w	3	
Physical geology	Geology 2w		3
Technical writing	English		2
Elective			5
		16	15

Electrical Engineering

SECOND YEAR

Calculus	Mathematics	3	3
General physics	Physics 3f, 4w	5	5
Mechanics of engineering	Mech. 1w		2
Materials of construction	C. E. 132f or w	3	
Elementary surveying	C. E. 102f or w		3
Drawing II, III	E. D. 2f, 3w	2	2
Metal work	I. A. 2f or w	2	
Military science and physical education		2	2
		17	17

Electrical Engineering

Third Year

Subject	Department and Course No.	Term.	
		Fall.	Winter.
Mechanics of engineering	Mech. 101f, 102w	3	3
Electrical machinery	E. E. 101f, 102w	4	4
Advanced calculus	Math.		4
Heat machinery, A	M. E. 131f or w	3	
Machine design, A	M. E. 101f or w		3
General economics	Econ. 1f	3	
Graphic statics	C. E. 120f	2	
Technical writing	English		2
		15	16

Fourth Year

Hydraulics	C. E. 140f or w		3
Advanced D. C. machinery	E. E. 103f	3	
Advanced A. C.	E. E. 110f	3	
Advanced A. C. machinery	E. E. 111w		4
Problems in D. C. design	E. E. 120w		2
Heat machinery, B	M. E. 132f	3	
Electives		6	6
		15	15

Mechanical Engineering

Second Year

Calculus	Math. f, w	3	3
General physics	Phys. 3f, 4w	5	5
Mechanics of engineering	Mech. 1w		2
Materials of construction	C. E. 132f or w	3	
Drawing II, III	E. D. 2f, 3w	2	2
Metal work	I. A. 2f or w	2	
Pattern making	I. A. 3f or w		2
Machine work	I. A.		2
Military science and physical education		2	2
		17	18

Third Year

Mechanics of engineering	Mechanics	3	3
Electrical machinery	E. E. 101f, 102w	4	4
Advanced calculus	Math.		4
Heat machinery, A	M. E. 131f or w		3
Machine design, A			3
Machine work	I. A.	2	
Economics	Econ. 1f	3	
Elementary surveying	C. E. 102f or w	3	
		15	17

Mechanical Engineering

FOURTH YEAR

Subject	Department and Course No.	Term. Fall.	Term. Winter.
Hydraulics	C. E. 140f or w	3	
Machine laboratory, A	M. E. 121f, 122w	2	2
Heat machinery, B	M. E. 132f, 133w	3	3
Machine design, B	M. E. 103w		3
Technical writing	English		2
Graphic statics	C. E. 120f	2	
Elective		4	4
		14	14

Note:—For the degree of Bachelor of Science in engineering at least two months' experience in some field of engineering or activity closely allied to engineering is required.

FIFTH YEAR

AGRICULTURAL ENGINEERING

Required Work:

			Hours
C. E.	291w.	Specifications and contracts	1
"	142w.	Water supply	2
Hort.	110f.	Landscape design	2
R. L.	110w.	Farm organization	3
A. E.	102w.	Irrigation and drainage	2
"	200f.	or w. Thesis	3
			13

At least 8 hours to be selected from the following group:

C. E.	120f.	Graphic statics	2
"	125w.	Masonry structures	3
E. E.	121w.	Electric motors	3
E. D.	3f.	Drawing III	2
M. E.	151f.	Heating and ventilation	3
"	154f.	Refrigeration	3
"	101w.	Machine design	3
Hort.	112w.	Spraying	2
F. C.	3f.	Field crop management	2
			23

CHEMICAL ENGINEERING

Required Work:

C. E.	291w.	Specifications and contracts	1
Chem.	141f.	Industrial chemistry	3
"	122f.	Quantitative chemical analysis	5
"		Thesis	3
			12

At least 8 hours to be selected from the following group:

Chem.	125w.	Quantitative organic analysis	6
"	133w.	Electro chemistry	5
"	142w.	Industrial chemistry	3
"	211f.	Advanced organic chemistry	5 to 6
"	227w.	Advanced analytical chemistry	2 to 5
Physics	104f.	Electrical measurements	4
Geol.	106f.	Mineralogy	5
Botany	3f.	General bacteriology	3
		Total	33 to 37

CIVIL ENGINEERING

Required Work:

C. E.	112f.	Railway location and construction	2
"	113w.	Economics of railway construction	2
"	222f.	Structural design	3
"	133w.	Testing laboratory	1
"	141f.	Water power	3
"	291w.	Specifications and contracts	1
			12

At least 8 hours to be selected from one of the following groups:

I.—Railway and Structural.

C. E.	214w.	Railway engineering	3
"	215w.	Railway yards and terminals	2
E. E.	241w.	Electric railway engineering	2
C. E.	223w.	Higher structures	3
"	226f.	Concrete structures	3
"	201w.	Geodetic surveying	3
			16

II.—Hydraulic and Geological.

C. E.	142w.	Water supply	2
"	243w.	Irrigation and drainage	2
"	244w.	Rivers and canals	2
"	201w.	Geodetic surveying	3
"	226f.	Concrete structures	3
Geol.	108w.	Rocks and rock minerals	3
"	100f.	Economic geology	3
			18

III.—Municipal and Highway.

C. E.	157w.	Sanitary design	2
Botany	3f.	General bacteriology	3
C. E.	142w.	Water supply	2
"	106f.	City planning	2
"	134w.	Road materials	3
"	110w.	Highway engineering	2
"	256f.	Highway design	2
			16

ELECTRICAL ENGINEERING

Required Work:

E. E.	221f.	Problems in A. C. design	2
"	230f.	or w. Generation and distribution	3
Physics	104f.	Eelectrical measurements	4
C. E.	291w.	Specifications and contracts	1
E. E.	298f, 299w.	Thesis	3
			13

At least 8 hours to be selected from the following groups:

I.—Power Group.

E. E.	242w.	Transmission	3
"	240w.	Central station design	2
C. E.	141f.	Water power	3
M. E.	133w.	Heat machinery B	3
"	131f, 122w.	Mechanical laboratory A	4
"	234f, 235w.	Gas engineering	4
			19

II.—Design Group.

E. E.	244w.	Analysis of design problems	2
M. E.	103w.	Machine design, B	3
E. E.	240w.	Central station design	2
"	250f.	Special electrical laboratory	2
"	280w.	Application of mathematics to E. E.	2
C. E.	124w.	Mill structures	2
			13

MECHANICAL ENGINEERING

Required work:

C. E.	291w.	Specifications and contracts	1
M. E.	111f.	Management engineering	3
"	151f.	Heating and ventilation	3
"	234f, 235w.	Gas engineering	4
			11

At least 8 hours to be selected from one of the following groups:

I.—Power Group.

C. E.	141f.	Water power	3
M. E.	134f.	Steam power plants	4
"	135f.	Steam turbines	2
"	231w.	Applied thermodynamics	3
"	154f.	Refrigeration, A	3
"	251w.	Railway mechanical engineering (locomotive)	2
			17

II.—Design and Manufacturing Group.

E. E.	131w.	Electric motors	2
"	133f.	Illumination	2

C. E.	133w.	Testing laboratory	1
M. E.	102f.	Technology of metals	2
"	104f.	Machine design	2
"	172w.	Engineering charts	1
"	211w.	Shopwork engineering	2
"	262w.	Railway mechanical engineering (design)	2
			14

Note:—Students electing any one of the above groups, who are interested in the principles of business or public administration, or in the field of pure science, may elect, with the approval of the adviser, work in the School of Business and Public Administration, or in the departments of mathematics and physics.

Applicants for the professional degrees must submit evidence of four months' experience in some field of engineering or activity closely related to engineering.

STATEMENT OF COURSES

Courses designated by a number with the letter f attached, thus: 100f, are given the fall term only. Those designated by a number with the letter w attached, thus: 100w, are given the winter term only.

Those designated by a number with the letters sp attached are given during the first eight weeks of the spring-summer term only, and those marked sm are given for the last eight weeks of the spring-summer term.

Courses numbered 200 and above are strictly graduate in character. *Arabic numerals in parenthesis indicate the number of hours credit a term.* A full description of courses will be found in the annual catalog, which may be obtained by addressing the Registrar, University of Missouri, Columbia, Missouri.

AGRICULTURAL ENGINEERING

1w. Farm Buildings (4) *Mr. Lehmann.*

2f, w, and sp. Farm Machinery and Farm Motors (3) *Mr. Jones.*

4f and sp. Construction Methods (2) *Mr. Lehmann, Mr. Jones.*

5w. Rural Sanitation (1) *Mr. Lehmann.*

6f and sm. Farm Surveying and Drainage (2) *Mr. Lehmann.*

100f, 101w, 102sm. Special Problems (2 to 5) *Mr. Lehmann, Mr. Jones.*

103f. Farm Motors (2) *Mr. Jones.*

104w and sm. Farm Shop Work (3) *Mr. Lehmann.*

106w. Irrigation and Drainage (2) *Mr. Lehmann.*

CHEMICAL ENGINEERING

Courses in this department not strictly engineering may be found in the general catalog under the department of chemistry.

CIVIL ENGINEERING

Topographical Engineering

102f, w, and sp. ELEMENTARY SURVEYING (3) *Mr. Williams, Mr. Miller.*

104w. HIGHER SURVEYING (4) *Mr. Williams.*

106f. CITY PLANNING (2) *Mr. Williams.*

107w. TOPOGRAPHIC SURVEYING FOR STUDENTS IN FORESTRY (3) *Mr. Williams.*

201w. GEODETIC SURVEYING (3) *Mr. Williams.*

Railway Engineering

111f. RAILWAY SURVEYING (3) *Mr. Miller.*

112f. RAILWAY LOCATION AND CONSTRUCTION (2) *Mr. Miller.*

113w. ECONOMICS OF RAILWAY CONSTRUCTION (2) *Mr. Miller.*

214w. RAILWAY ENGINEERING (3) *Mr. Miller.*

215w. RAILWAY YARDS AND TERMINALS (2) *Mr. Miller.*

Structural Engineering

120f and w. GRAPHIC STATICS (2) *Mr. Hyde.*

121f. STRESSES (3) *Mr. Hyde.*

122w. FRAMED STRUCTURES (2) *Mr. Hyde.*

124w. MILL STRUCTURES (3) *Mr. Spalding.*

222f. STRUCTURAL DESIGN (3) *Mr. Hyde.*

223w. HIGHER STRUCTURES (3) *Mr. Hyde.*

226f. CONCRETE STRUCTURES (3) *Mr. Spalding.*

227f or w. THEORY OF STRUCTURES. *Mr. Hyde.*

Materials of Construction

132f. MATERIALS OF CONSTRUCTION (3) *Mr. LaRue, Mr. Spalding.*

133w. TESTING LABORATORY (1) *Mr. LaRue.*

134w. ROAD MATERIAL (3) *Mr. LaRue.*

231f or w. EXPERIMENTAL INVESTIGATION.

Hydraulic Engineering

140f or w. HYDRAULICS (3) *Mr. Rodhouse.*

141f. WATER POWER (3) *Mr. Rodhouse.*

142w. WATER SUPPLY (2) *Mr. Rodhouse.*

243f. IRRIGATION AND DRAINAGE (2) *Mr. Rodhouse.*

Municipal Engineering

151f. ROADS AND PAVEMENTS (2) *Mr. Spalding.*

152f. SANITARY ENGINEERING (2) *Mr. McCaustland.*

155w. HIGHWAY ENGINEERING (2) *Mr. Spalding.*

157w. SANITARY DESIGN (2) *Mr. McCaustland.*

256f. HIGHWAY DESIGN (2) *Mr. Spalding.*
257f or w. SANITARY ENGINEERING. *Mr. McCaustland.*

General

291w. SPECIFICATIONS AND CONTRACTS (1) *Mr. Spalding.*
299w. THESIS (1) fall term; (2) winter term.

ENGINEERING DRAWING

1f or w or sp. DRAWING I (2) *Mr. Newton.*
2f or w or sp. DRAWING II (2) *Mr. Newton, Mr. Miller.*
3f or w or sp. DRAWING III (2) *Mr. Newton.*

ELECTRICAL ENGINEERING

101f, 102w. ELECTRICAL MACHINERY (4) *Mr. Weinbach, Mr. Miller.*

103f. ADVANCED DIRECT CURRENT MACHINERY (3) *Mr. Lanier, Mr. Miller.*

110f. ADVANCED ALTERNATING CURRENTS (3) *Mr. Weinbach, Mr. Miller.*

111w. ADVANCED A. C. MACHINERY (4) *Mr. Lanier.*
120w. PROBLEMS IN DIRECT CURRENT DESIGN (2) *Mr. Lanier.*
131w. ELECTRIC MOTORS (2) *Mr. Weinbach.*

132f. STORAGE BATTERY ENGINEERING (2) *Mr. Weinbach.* (Not offered in 1920-21.)

133f. ILLUMINATION (2) *Mr. Miller.*
134w. TELEPHONY (2) *Mr. Weinbach.*
143w. ELECTRICAL PROCESSES (2) *Mr. Weinbach.*
221f. PROBLEMS IN ALTERNATING CURRENT DESIGN (2) *Mr. Lanier.*
230f. GENERATION AND DISTRIBUTION (3) *Mr. Weinbach.*
240w. CENTRAL STATION DESIGN (2) *Mr. Miller.*
241w. ELECTRIC RAILWAY ENGINEERING (2) *Mr. Miller.*
242w. TRANSMISSION (3) *Mr. Weinbach.*
244w. ANALYSIS OF DESIGN PROBLEMS (2) *Mr. Lanier.*
250f. SPECIAL ELECTRICAL LABORATORY (2) *Mr. Lanier.*

280w. APPLICATION OF MATHEMATICS TO ELECTRICAL ENGINEERING (2) *Mr. Weinbach.*

290. RESEARCH.
298f, 299w. THESIS (1) fall term; (2) winter term.

INDUSTRIAL ARTS

1f and w. WOODWORK (2) *Mr. Allton; Mr. Wilkes.*
2f and w. METAL WORK (2) *Mr. Allton.*
3f and w. PATTERN MAKING (2) *Mr. Wilkes.*
4f and w. MACHINE WORK (4) *Mr. Schneitter.*
5f. TOOLS AND MATERIAL (1) *Mr. Selvidge.*

133w. Advanced Molding and Foundry Practice (3) *Mr. Allton.*
134f. Advanced Pattern Making (3) *Mr. Wilkes.*
135f. Advanced Forge Work (3) *Mr. Allton.*
136f or w. Advanced Machine Work (3) *Mr. Schneitter.*

MECHANICAL ENGINEERING

Design

101f and w. Machine Design, A (3) *Mr. Newton.*
102f. Technology of Metals (2) *Mr. Hibbard.*
103w. Machine Design, B (3) *Mr. Newton.*
104f. Machine Design, C (2) *Mr. Newton.*
201f and w. Special Machine Design.

Industrial Engineering

111f and w. Management Engineering (3) *Mr. Hibbard.*
211w. Shopwork Engineering (2) *Mr. Hibbard.*

Testing and Experimental Engineering

121f, 122w. Mechanical Laboratory, A (2) *Mr. Wharton.*
123f. Mechanical Laboratory, B (2) *Mr. Wharton.*
221f or w. Special Mechanical Laboratory.

Power Engineering

131f and w. Heat Machinery, A (3) *Mr. Wharton.*
132f, 133w. Heat Machinery, B (3) *Mr. Wharton.*
134f. Steam Power Plants (4) *Mr. Hibbard.*
135f. Steam Turbins (2) *Mr. Newton.*
231w. Applied Thermodynamics (3) *Mr. Wharton.*
234f and w. Gas Engineering (2) *Mr. Wharton.*

Power Applications

151f. Heating and Ventilation (3) *Mr. Newton.*
154f. Refrigeration, A (3) *Mr. Wharton.*
251w. Refrigeration, B *Mr. Wharton.*
261f and 262w. Railway Mechanical Engineering (2) *Mr. Hibbard.*

The student may elect work in this course along the lines of railway shops, car design, locomotive design, or locomotive operation.

General

171w. Seminary (1) *Mr. Hibbard.*

MECHANICS

1f, w or sp. Mechanics of Engineering (2) *Mr. Defoe, Mr.* ———.
103f and 104w. Mechanics of Engineering (4) *Mr. Defoe.*

112f and w. ADVANCED MECHANICS (3) *Mr. Defoe.*
205f and w. ELASTICITY (3) *Mr. Defoe.*

OTHER COURSES

The following courses offered in the College of Arts and Science are of particular interest to students in the School of Engineering:

ASTRONOMY. 1f or w, *descriptive astronomy;* 103f, *geodetic astronomy.*

ECONOMICS. 1f or w, *general economics;* 106 f or w, *problems of labor;* 117f or w, *accounting;* 233f or w, *valuation of public utilities.*

GEOLOGY. 1f or w, *physical geology;* 4w, *rocks and minerals;* 100f, *economic geology;* 107f, *field geology.*

MATHEMATICS. 120f and w, *differential equations and their applications.*

PHYSICS. 104f, *electrical measurements;* 110w, *electricity, and magnetism;* 207, *theory of electricity and magnetism;* 112f, *heat;* 206, *theory of heat;* 221w, *electrical waves.*

GRADUATE WORK IN ENGINEERING

Graduates of the School of Engineering holding professional degrees (C.E., M.E., E.E., Ch.E.) will be admitted to candidacy for the degree of Doctor of Philosophy (Ph.D.) in the Graduate School upon the completion of a minimum of four terms of additional work.

Graduates of other schools of engineering in good standing who have completed five years of university work will be admitted on the same basis. A minimum of six terms of graduate work will be required of all graduates of engineering schools who have completed only eight terms of university work.

The faculty of the Graduate School reserves the right to pass on the qualifications of all candidates.

The graduate student is expected to devote the greater part of his time to research work. A part of the time may be given to some of the advanced courses in engineering, or other university courses allied to the main subject of study.

The work of each candidate is under the supervision of a special committee of the faculty, whose function is to advise the student in regard to his course of study and the subject of his research.

The usual work consists of the investigation of some engineering problem of practical or scientific importance. In this the student is thrown largely upon his own resources, and must show originality and capability of accurate scientific thinking. The results of the researches are to be embodied in a dissertation which shall give evidence of the merit of the work and the ability of the student. The regulations governing the degree of Doctor of Philosophy are given in the annual catalog.

The equipment and funds of the Engineering Experiment Station are available for experimental research, provided the subjects being investigated are of such practical importance as to conform to the general purpose for which the experiment station was established.

A limited number of research assistants in the Engineering Experiment Station are appointed each year, and, under suitable conditions, work carried on by these assistants may count toward the Doctor's degree. This makes the research assistantship equivalent to a graduate fellowship, enabling the candidate thus appointed to work toward his degree and at the same time earn his expenses during a part of the time.

For further information regarding graduate work, address DEAN OF THE GRADUATE FACULTY, UNIVERSITY OF MISSOURI, COLUMBIA, MISSOURI.

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Instructor in Physics.

THE ENGINEERING EXPERIMENT STATION

Officers of the Station

ALBERT ROSS HILL, A. B., Ph. D., LL. D., *President of the University.*

ELMER JAMES McCAUSTLAND, C. E., M. C. E., *Dean of the Faculty of Engineering, Director of the Engineering Experiment Station.*

The Engineering Experiment Station of the University of Missouri was established by order of the Board of Curators, July 1, 1909.

The object of the station is to be of service to the people of the State of Missouri:

First, by investigating such problems in engineering lines as appear to be of the most direct and immediate benefit and publishing these studies and information in the form of bulletins.

Second, by research of importance to the manufacturing and industrial interests of the state and to engineers.

The staff of the station consists at present of a director and four research assistants together with a number of teachers who have undertaken research under the direction of the station.

Suggestions as to problems to be investigated, and inquiries will be welcomed.

Bulletins have been published as follows:

Vol. 1, No. 1, *Acetylene for Lighting Country Homes,* by J. D. Bowles, research assistant, 1909-10.

Vol. 1, No. 2, *Water Supply for Country Homes,* by K. A. McVey, research assistant, 1909-10.

Vol. 1, No. 3, *Sanitation and Sewage Disposal for Country Homes,* by W. C. Davidson.

Vol. 2, No. 1, *The Heating Value and Proximate Analysis of Missouri Coals,* by C. W. Marx and Paul Schweitzer. (a reprint.)

Vol. 2, No. 2, *Friction and Lubrication Testing Apparatus,* by Alan E. Flowers.

Vol. 2, No. 3, *Tests of Road Materials of Missouri,* by W. S. Williams and Warren Roberts.

Vol. 3, No. 1, *The Use of Metal Conductors to Protect Buildings From Lightning,* by E. W. Kellogg.

Vol. 3, No. 2, *Firing Tests on Missouri Coal,* by H. N. Sharp, research assistant, 1911-12.

Vol. 3, No. 3, *A Report on Steam Boiler Trials Under Operating Conditions,* by A. L. Westcott.

Vol. 4, No. 1, *Economics of Rural Distribution of Electric Power,* by L. E. Hildebrand, research assistant, 1912-13.

Vol. 4, No. 2, *Comparative Tests of Cylinder Oils,* by M. P. Weinbach.

Vol. 4, No. 3, *Artesian Waters of Missouri,* by A. W. McCoy, research assistant, 1912-13.

Vol. 4, No. 4, *Friction Tests of Lubricating Grease and Oils,* by A. L. Westcott.

Engineering Experiment Station Series 14, *A Study of the Effect of Heat on Missouri Granites,* by W. A. Tarr and L. M. Neuman, research assistant, 1913-14.

Engineering Experiment Station Series 15, *A Preliminary Study Relating to the Water Resources of Missouri,* by T. J. Rodhouse.

Engineering Experiment Station Series 16, *The Economics of Electric Cooking,* by P. W. Gumaer.

Engineering Experiment Station Series 17, *Earth Roads and the Oiling of Roads,* by H. A. LaRue.

Engineering Experiment Station Series 18, *Heat Transmission Thru Boiler Tubes,* by E. A. Fessenden and J. W. Haney, research assistant, 1915-16.

Engineering Experiment Station Series 19, *Geology of Missouri,* by E. B. Branson.

The following studies are now in progress: Coal testing, Investigation of Asphaltic sandstones of Missouri, Insulating value of paints and varnishes, Water resources of Missouri, Artificial illumination, Missouri clays, Water power in Missouri, Metallic alloys, Available road materials in Missouri. Besides these a number of detailed studies of materials and processes and investigations of Missouri's resources are in progress.

A standardizing laboratory has been established and the apparatus is now available for tests of electric, gas, and water meters of practically all types.

The State Highway Department is making use of the laboratories of the Engineering Experiment Station for the testing of road materials used in the state.

Any resident of the state may, on request, obtain the bulletins as issued. Those who are particularly interested may have their names placed on the regular mailing list. Address Director, Engineering Experiment Station, University of Missouri, Columbia, Missouri.

For further information concerning the School of Engineering, address E. J. McCaustland, Dean, Faculty of Engineering, University of Missouri, Columbia, Missouri.

The general University catalog or special bulletins of any departments will be sent upon request to The Registrar, University of Missouri, Columbia, Missouri.

INFORMATION ABOUT THE UNIVERSITY

The fundamental aim of the University of Missouri is the development of the highest and most efficient type of citizen. For the purpose of accomplishing its aim, the University furnishes ample facilities for liberal education and for thoro professional training. The University is a part of the public educational system of the state.

The work of the University is now carried on in the following divisions: College of Arts and Science, College of Agriculture, School of Education, School of Law, School of Medicine, School of Engineering, School of Mines and Metallurgy, School of Journalism, School of Business and Public Administration, Graduate School, Extension Division.

All of these divisions are at Columbia, with the exception of the School of Mines and Metallurgy, which is at Rolla. In addition, emphasis is given particular lines of work by the establishment of minor divisions, the chief of which are the Agricultural Experiment Station, the Engineering Experiment Station, and the Missouri State Military School.

The University of Missouri is at Columbia, half way between St. Louis and Kansas City, near the center of the state. It is reached by the Wabash and by the Missouri, Kansas, & Texas railways. Columbia is a progressive and prosperous city.

The University grounds cover more than 800 acres. The main divisions are in the west campus, the east campus, the athletic fields, and the University farm. About forty University buildings are at Columbia.

THE
UNIVERSITY OF MISSOURI
BULLETIN

GENERAL SERIES

EDITED BY
CHARLES E. KANE
University Publisher

The General Series of the University of Missouri Bulletin consists of the University Catalog and the announcements of the various colleges and schools which make up the University. These announcements will be sent free upon request to the Registrar, University of Missouri, Columbia, Missouri.

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VOLUME 20, NUMBER 10

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GENERAL SERIES
1921, No. 7.

SCHOOL OF ENGINEERING

ANNOUNCEMENT 1921-22

ISSUED THREE TIMES MONTHLY; ENTERED AS SECOND-CLASS MATTER AT POSTOFFICE AT COLUMBIA, MISSOURI—4,500
APRIL, 1921

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CALENDAR FOR 1921-1922

Fall Term

1921		
August 29	Monday, entrance examinations	
August 30, 31	Tuesday, Wednesday, registration	
September 1	Thursday, 8 a. m., class work begins	
October 31	Monday, 8 a. m. to	First term, Two-Year Winter Course in Agriculture.
December 21	Wednesday 4 p. m.	
November 24	Thursday, Thanksgiving Day, holiday	
December 21	Wednesday, 4 p. m., fall term closes	

Winter Term

December 30, 31	Friday, Saturday, registration	
January 2	Monday, 8 a. m., class work begins	
January 2	Monday, 8 a. m., to	Second term, Two-Year Winter Course in Agriculture.
February 24	Friday, noon	
February 22	Wednesday, Washington's Birthday, holiday	
April 23	Sunday, Baccalaureate Address	
April 26	Wednesday, Commencement Day	

Spring-Summer Term

April 27	Thursday, term opens
June 17	Saturday, noon, first half of term ends
June 19	Monday, 8 a. m., second half of term begins
July 4	Tuesday, Independence Day, holiday
August 12	Saturday, noon, spring-summer term ends

FOREWORD---THE PROFESSION

OPPORTUNITIES FOR ENGINEERING GRADUATES

The activities of the recent war served to emphasize the great need for a more general extension of technical training. Such training has a value outside the narrow limits of professional application and it has fully demonstrated this in the field of general business and public affairs. Plans are in process of formulation that will enable underclassmen in the School of Engineering to come more closely in contact with business and industrial affairs. It is hoped that this contact will serve to motivate the work of the student and to assist him in giving direction to his preparation.

The consensus of engineering judgment thruout the country favors an increasing attendance at the technical schools in order to prepare a large number of trained men to meet the pressing needs of the near future.

The field of engineering and technical training is especially commended to those who may be contemplating a preparation for their life work, and who feel that their ability to serve their country to the best advantage may lie in aptitudes developed by technical training.

The War Department is seeking to make use of the advantages of engineering training in the universities of the country, and the Chief of Engineers of the United States Army has reported favorably upon the School of Engineering of the University of Missouri as a place for the organization of an engineering unit in the Reserve Officers Training Corps. The outlook in the field of engineering is especially encouraging to young men of character, ability, and willingness to work.

THE MODERN ENGINEER—RELATION TO SOCIETY

About the middle of the nineteenth century the industrial development which had followed the invention of the steam engine became so highly specialized that engineers found it necessary to restrict their individual fields of practice. Previous to this period, engineering had developed out of the needs of the military and later the needs of civil organizations, thus producing two classes in the profession known respectively as military engineers and as civil engineers, with no further divisions into specialties. Progress in the art of engineering came thru the extension of practice rather than from a study of the fundamental laws of science underlying the art. The modern point of view, however, emphasizes the value of a thoro knowledge of the laws of science which serve as the foundation upon which the practice of the profession may be developed.

The study of present social conditions in the civilized world reveals the fact that the advances of the last one hundred and fifty years are founded largely on the work of the engineer, whose application of the discoveries of modern science has brought about conditions leading to improved health, comfort and the conveniences of living. The economic history of the past century is also closely interwoven with, and to a large degree dependent upon, the inventions and mechanical developments of the engineer.

These facts give emphasis to the statement that there are excellent opportunities in modern life and industry for able and well trained engineers. The financial rewards are not usually as great as may be gained in commercial life altho there is a distinct tendency at the present time to value more highly and to increase the compensation for the services of engineers. However, the true engineer has an enthusiasm for his work which makes *opportunity for service* more attractive to him than the opportunity for personal gain.

Engineers find employment in the service of various corporations, as designing engineers for structural work or for machines, and finally after considerable experience, they may prosper as independent consulting engineers. Many abandon technical practice altogether and enter administrative or managerial positions or seek service in the business organizations of the industrial enterprises.

The development of governmental control of public utilities opens a way for the employment of many engineers who may be called upon to fix rates and enforce standards of quality, quantity and service; their judgment may be needed also to authorize or forbid bond issues, depending upon the financial and physical condition of the corporation. In the exercise of these and similar functions, the engineer should be well equipped with technical knowledge, and he should also have some understanding and appreciation of the legal, economic, commercial, social and ethical questions involved in such problems as valuation and rate fixing.

Public ownership of utilities such as the municipal ownership of electric light and power, water, gas and transportation plants, opens the way for further work for the engineer. The earlier type of municipal engineer whose practice was largely confined to planning and overseeing the construction and maintenance of streets and pavements, sewers, parks and water mains, was best trained as a civil engineer. For municipalities owning and operating their public utilities such as water supply, power and light plants, etc., the office of city engineer may well be filled by a mechanical engineer.

The development of engineering into specialties has became a characteristic of modern practice and schools recognize this in the outlining of curricula. Some of these special fields are briefly outlined below.

DIVISION INTO SPECIALTIES

Agricultural Engineering

The most recent subdivision of engineering has to do with the applications of the art to agricultural problems such as drainage, irrigation, water supply and sewerage for the farm, design of farm machinery, etc. The field open to agricultural engineers ranges all the way from strictly engineering work to the general management of large farm operations. Many drainage and irrigation projects intended to develop agricultural resources have failed because attention was concentrated upon the engineering features and little attention given to agricultural phases of the problem until the work was practically completed.

Training in agricultural engineering contemplates a thoro understanding of the elementary principles underlying both agriculture and engineering.

Chemical Engineering

Engineers with special training in chemistry, who devote themselves to the development of the various chemical industries, are known as chemical engineers. Much of recent progress is due to the discovery and development of new materials and compounds with characteristics that make them valuable in the arts. A great part of the research being carried on for commercial purposes lies along these lines. A man who has had a thoro training in chemistry, and who combines with his knowledge of chemistry an insight into physical and mechanical problems and an appreciation of the commercial significance of his work, is best qualified to make himself valuable in investigation of this kind. Not only the discovery of new products, but the maintenance of a standard of quality in manufactured materials, demands the labor of men who have a knowledge of chemistry.

This field of work is rapidly becoming very large because of the many and varied industries which have been and are being developed.

Civil Engineering

The term civil engineering is still often used in its original sense as covering all engineering not military, but commonly it is limited to those fields of practice not included in the other branches.

In the number of special fields of work included, it is the broadest branch of engineering practice. It comprises:

Surveying, which in simple forms is used by all civil engineers, but which when applied in geodetic and topographic work may constitute a distinct field of practice.

Hydraulic engineering which includes the design and construction of harbors and docks, river improvements, canals, irrigation works, drainage and flood prevention, and water power projects.

Sanitary engineering, covering all works designed to protect the public health, such as water supply and water purification, sewerage and sewage disposal, and the disposal of garbage and refuse.

Highway engineering, in which may be included both the maintenance and improvement of country roads and the construction and maintenance of city streets and pavements.

Railway engineering, which deals with the design, construction, and maintenance of all works required for steam and electric railways.

Structural engineering, which is concerned with the design and construction of bridges and of the structural features of large buildings that carry heavy loads, masonry and concrete structures, and heavy foundations.

General construction, under which head may be included the execution of large works of construction, and the transportation and handling of heavy materials.

Electrical Engineering

Engineers who are concerned mainly with the generation, transmission, or utilization of electrical energy are known as electrical engineers.

The last few years have seen a great increase in the applications of electricity, and the field of its usefulness is constantly widening. The special fields of most importance into which electrical engineering is divided are:

The design and construction of generators, motors, and other apparatus required in the generation, distribution, and utilization of electric power.

The design, construction, and operation of plants for generating electric power and lines for its transmission.

The application of electricity to industrial power.

The building and operation of electric railways.

The utilization of electric energy for lighting purposes.

The design, construction, and operation of telephone and telegraph systems.

The application of electricity in the various chemical industries.

Industrial Arts

The industrial arts cover that phase of the engineer's work which deals with manufacturing and with production management.

Reducing cost of production and keeping quality up are his main problems. He determines the size of the production units, co-ordinates the production of these units until they are produced in proper proportion, considers material costs, labor costs, labor turn-over, training workmen and foremen, organized labor, handling men, and other problems affecting efficiency in production.

Mechanical Engineering

The term mechanical engineering is usually employed to designate the work of those engineers who have to do primarily with steam or other engines, machine tools, mill work, and moving machinery in general. The lines of work included in the practice of a mechanical engineer may be:

Power engineering, which consists in the design, construction and operation of machines and plants for the generation of power. These may include steam, gas, oil, or other engines, with all the auxiliary appliances necessary to their operation, as well as the various methods of power distribution.

Design of plants and machinery for the utilization of power, requiring the study of special processes for which machinery may be required, and the adaptation of machines and arrangement of plants for purposes of economical production.

Shop management, dealing with the control and management of shops in the operation of manufacturing plants.

Gas engineering, covering the production, distribution, and utilization of gas for light, heat, and power purposes.

Railway mechanical engineering, consisting of the design, construction, and operation of rolling stock and other machinery, and of the shops required in the operation of railways.

BUILDINGS AND EQUIPMENT

The departments of electrical and mechanical engineering of the University of Missouri at Columbia occupy the main Engineering Building and the department of civil engineering occupies a part of Switzler Hall. The work in chemistry required of students in chemical engineering is given in the Chemistry Building and the specialized work in agricultural engineering is offered in the Farm Machinery Building.

The main engineering laboratories are in the Engineering Annex in the rear of the Engineering Building. A substantial addition to the Engineering Annex is now being used for the expansion of the mechanical engineering laboratory and for the development of a hydraulic laboratory. Shop work is conducted in a building recently erected for the purpose.

AGRICULTURAL ENGINEERING. This laboratory contains a large assortment of the best modern machinery, including one or more samples of the principal field and power machines. A line shaft driven by an electric motor is available for demonstrating these machines.

For instruction in gas engines and tractors, the laboratory is equipped with ten stationary and portable gasoline and oil engines and samples of the latest type of tractors with suitable equipment for testing them. Lighting units are provided for work on farm lighting systems. Drafting tables are provided to accommodate the men designing farm buildings.

The equipment for concrete work includes a complete set of concreting tools, molds for building blocks, forms for fence posts, water troughs, and tanks and tile machines, with small apparatus for testing cement and aggregates. A level and transit with complete set of tools are provided for tile drainage work.

CHEMICAL ENGINEERING. In addition to the laboratories in general chemistry, there are separate laboratories for the other fundamental courses in chemistry required in the chemical engineering curriculum. The general analytical laboratory offers facilities for work in qualitative and quantitative analysis. Special work in the technical analysis of fuels, water, gas, and commercial products is given in smaller laboratories equipped especially for these lines of work. Two laboratories are available for general work in organic chemistry, and more advanced work along organic lines is provided for in a furnace room and a laboratory for the preparation of organic compounds. The laboratory in physical chemistry is equipped for work in electro-chemistry and measurements in radio-activity. Advanced students have an opportunity to pursue work in metallography. The electrical laboratories in the Engineering Building offer facilities for work in electro-plating, storage battery engineering, and electrical processes.

CIVIL ENGINEERING. The laboratory for testing materials is in charge of the department of civil engineering. The equipment includes several vertical testing machines with all necessary accessories for tension, compression, and transverse tests on the ordinary engineering materials, iron, steel, cement, concrete, brick; a beam-testing machine; a torsion machine; impact and abrasion machines. There is also complete equipment for all the standard tests upon hydraulic cement.

The road materials laboratory contains the necessary machines for making complete tests upon stone for road purposes, a standard rattler for paving brick tests, and the apparatus required in investigating bituminous road materials.

There is a good collection of surveying instruments, including the instruments used in ordinary field practice and those necessary for precise surveying and geodetic work.

Stream gages, with a dam and weirs on streams near Columbia, afford opportunity for field study of water supply problems, while practice in hydrographic surveying and stream measurements is obtained by a trip to a river in the neighborhood.

HYDRAULIC LABORATORY. A new hydraulic laboratory has been equipped recently for the study of problems where large quantities of flowing water are needed. Two large size direct-connected electric motor-driven centrifugal pumps have been installed. These pumps will supply water for investigations relating to the flow of water in flumes, large pipes, and conduits; to the discharge over dams and weirs, thru racks, sluices, and submerged orifices; and to other features encountered in the water power and water supply developments.

Apparatus has been installed for the study of the flow of water thru pipes, fire hose and nozzles, and the effect of valves and bends; for the study of the flow of water thru sand filters, and of ground-water flow in soil drainage; and for the testing of pumping machinery and water wheels.

Full equipment for the accurate measurement of quantities, velocities, and pressures, both in open and closed channels, is available, and includes the latest types of Pitot tubes, automatic self-recording gages and water meters.

ELECTRICAL ENGINEERING. The electrical engineering laboratory contains direct and alternating current generators and motors of the common types met with in practice and all the instruments necessary to make complete tests of their operation. Besides several low-ratio transformers used in routine exercises, the laboratory has a 10,000-volt transformer for testing dielectric strengths, one of 40,000-volts and one 10 KVA of 100,000 volts for high tension experiments. A set of Edison cells and one of chloride cells are available for experiments on storage batteries.

A low voltage motor-generator set is provided for general electro-chemical processes such as electro-plating with gold, silver, nickel, and copper. One large and several small electric furnaces are used for demonstrations of the electric processes involved in the production of carborundum, graphite, emery, calcium carbide, feroalloys.

The telephone equipment comprises a demonstration board showing all the apparatus and operations involved in a connection thru two offices. For experiments in telephone transmission, there is a high frequency generator and an artificial line, which is electrically equivalent to fifty miles of underground wire.

The laboratory also has a quadruplex telegraph set.

INDUSTRIAL ARTS. The engineering shops contain a very complete equipment of machines and hand tools for the woodworking trades, such as carpentry, mill work, cabinet making and pattern making.

For the metal working trades there are a well-equipped blacksmith shop, machine shop and oxy-acetylene welding shop.

MECHANICAL ENGINEERING. The mechanical engineering laboratory contains several different types of steam engines, a small steam turbine with a superheater, condensers, gas engines, reciprocating and centrifugal pumps, a number of fans, blowers, and heating coils for work on ventilation and heating, and a variety of other machinery. Much attention is paid to the study for fuels of all kinds. Complete standard apparatus for determining the analysis and calorific value of coals and gases is provided. The laboratory is supplied with the usual equipment of indicators, gases, water and gas meters, scales, and other necessary accessories.

The central power plant of the University is used for conducting boiler tests under actual operating conditions. Considerable attention is given to the study of refrigeration. Several small ice and cold storage plants belonging to the University are available for tests. A local privately owned plant is also sometimes used.

A high grade lathe, completely equipped for use in connection with courses in shop efficiency, has been purchased recently. It will be used to make production tests to determine the proper kinds of tools and the best cutting speeds to use in making machine parts.

LIBRARY. The engineering library in the Engineering Building has 5,000 standard engineering books. These have been carefully selected and include the works of all the best American and English engineering authors. About 100 periodicals are regularly received, together with publications recording the transaction of the more important engineering societies.

Engineering students are permitted free access to the library shelves for reference and are encouraged to draw books for outside reading.

The general library of the University and the library of the State Historical Society, together containing about 250,000 books and pamphlets, are open to all students in the University.

STUDENT ACTIVITIES

Engineering Societies

The Engineers' Club is made up of students from all classes and, as its main function, affords opportunities for close acquaintance among the students in the school.

Branches of two national engineering societies, the American Institute of Electrical Engineers and the American Society of Mechanical Engineers, have been established for several years. Meetings of each are held semi-monthly for the discussion of current engineering problems, usually drawn from the publications of the national societies received regularly by the members of the branches. Practically all of the upperclassmen in electrical engineering and mechanical engineering are active members of one or the other of the branches, and a great deal of interest is taken in the meetings. These societies are strongly encouraged because of the benefits to be derived from practice in preparing and delivering papers before a critical audience and for the acquaintance with the activities of the prominent engineers composing the national societies.

During 1913, the Civil Engineers' Society, working along lines similar to those followed by the branches discussed above, was organized. This society is not affiliated with a national society.

In 1919 a chapter of the American Association of Engineers was given a charter, and the organization now has about 200 members.

Athletics

Students in all divisions of the University are encouraged to take part in athletics in one form or another. Class teams and Varsity teams are maintained in football, baseball, basketball, tennis and track. These are all carefully supervised and are under the direction of the experienced coaches and trainers.

Rothwell Gymnasium is well lighted and well ventilated and equipped with the usual apparatus. Bathing, locker and dressing facilities are provided in the basement.

Rollins Field, named in recognition of the generosity of members of the Rollins family, is just west of Rothwell Gymnasium. It contains a quarter-mile cinder track, 220-yard straightaway, grounds for field athletics, a gridiron for football, and a baseball field. All intercollegiate contests are held here.

Concrete bleachers which seat 4,250 persons have been constructed. A new concrete fence with ornamental gate partly surrounds Rollins Field.

Tennis courts, basketball courts, baseball, football, and soccer fields for all students are situated near the gymnasium.

MILITARY AND PHYSICAL TRAINING

REQUIRED. All physically fit men students in the University are required to take four terms of Military Science and Tactics and Physical Training during their freshman and sopohomore years.

ADVANCED COURSE. Any student who has completed two academic years in the course, and who has been selected for further military training, may be enrolled for an advanced course of four terms upon executing an agreement in writing. *Students taking the advanced courses* (5 *hours a week*) *will be paid commutation of subsistence by the United States.* Upon completion of the advanced course, they are eligible for appointment in the Officers' Reserve Corps, and as temporary second lieutenants in the Regular Army. Eight hours' credit toward graduation is allowed for this work.

FEES AND EXPENSES

TUITION. Tuition is free in all divisions of the University to students who are residents of the state. Non-residents of the state are required to pay a tuition fee of $10 a term in all divisions of the University, except in the Graduate School.

LIBRARY, HOSPITAL, AND INCIDENTAL FEE. All students in the University except those specially exempt by law or by rule of the Curators are required to pay a library, hospital, and incidental fee of $25 for each registration.

LABORATORY CHARGES. In all the departments where the equipment is exposed to depreciation, due to its being used by the student for purposes of receiving instruction, or where material of any description is furnished by the department and consumed by the student, departmental fees are collected in accordance with the following regulations:

A fixed charge, which shall in no case be less than $1, is made for the individual courses in the laboratories and for other courses in which material or apparatus is used as described above. This fixed charge or fee is made to cover the cost of material used and wear of instruments as ascertained by experience in each particular laboratory and course.

Extra charges for breakage, etc., may be made in case the loss to the University is not covered by the regular charge. For details consult the annual catalog. All fees must be paid in advance.

BOOKS AND INSTRUMENTS. The cost of books varies considerably depending upon the courses being taken each year; a fair average is from $25 to $35 a term. A good set of drawing instruments is required in the first year's work in mechanical drawing and is used thruout the course. This costs from $15 to $25, depending upon the quality.

ROOM RENT AND BOARD. Rooms may be rented in Lathrop Hall, the University dormitory for men, at from $14 to $20 for each student for a term of sixteen weeks. Two students occupy each room and the rent depends upon the location of the room.

For rooms in private houses, from $10 to $16 a month is charged, the average being about $13. This is usually shared by two students.

The Commons, run under the direction of the University, consists of a cafeteria in Lathrop Hall. Meals are served at cost.

Board in private boarding houses usually costs from $5.50 to $7.50 a week. Private boarding clubs are formed in which the average cost is somewhat less.

TOTAL EXPENSES. The table below is intended to give an idea as to the probable expenses per term of a student in the University.

Fees	$25
Board	95
Rent	25
Laundry	15
Books and stationery	30
Miscellaneous	50
Total	$240

Clothing and railroad fares are not included in this table. The actual expenditures will depend largely upon the tastes and inclinations of the individual student.

There are many opportunities for a student to earn money to pay part or all of his expenses at Columbia. The Y. M. C. A. conducts an employment bureau to aid students in finding work of this kind. Students who must spend part of their time in outside employment should not expect to take full work in the University and under these circumstances an additional year is often required to satisfy the requirements for graduation. Students coming to Columbia for the first time should not expect to find work at once, but must have some funds available to meet necessary expenses until employment is obtained. This may require several months. Information regarding employment may be had by addressing, Secretary, Employment Bureau, Y. M. C. A. Building, Columbia, Mo.

REQUIREMENT FOR ADMISSION

Fifteen units, the equivalent of a 4-year high school course, are required for admission as a regular student in the School of Engineering.

A unit is the equivalent of a subject pursued five periods a week for at least thirty-six weeks, four units constituting a year's work.

CURRICULA AND DEGREES

There are five curricula leading respectively to the professional degrees of Agricultural Engineer, Chemical Engineer, Civil Engineer, Electrical Engineer, and Mechanical Engineer. The requirement for a professional degree is 166 credit hours, or ten and one-half terms of college work. The work of the first two and one-half terms is the same in all curricula and is outlined in the tables which follow. The additional requirements are further tabulated and listed.

The degree of Bachelor of Science in Engineering may be given at the end of eight and one-half terms of college work for a total of 136 credit hours as shown in the following tables.

Students may obtain both the A. B. and a professional engineering degree in twelve and one-half terms. Those who can afford the additional time required are urged to take advantage of the opportunity thus afforded for general cultural training combined with an engineering education. This is made possible by—

(a) The acceptance of the following subjects (to a maximum of 20 credit hours) for the A. B. degree: mechanics (courses 101, 103 and 112); electrical machinery (electrical engineering, courses 101 and 102) 8 hours; applied thermodynamics (mechanical engineering, course 231), 3 hours; elementary surveying (civil engineering, course 102), 3 hours; woodwork (industrial arts, course 1), 2 hours; metal work (industrial arts, course 2), 2 hours; drawing (engineering drawing, courses 1 and 2), 4 hours.

(b) The waiving of certain restrictions in the choice of electives in the School of Engineering, for students having an A. B. degree.

Students desiring to take both the A. B. and a professional engineering degree should plan their work carefully from the beginning to insure that the following items are accomplished in their first eight terms:

1. The completion of all the requirements of the A. B. degree (see the annual catalog).
2. The completion of sufficient electives chosen from the subject from the School of Engineering that are accepted toward an A. B. degree (see list in paragraph (a) above) to reduce the required engineering courses remaining to be taken in the last four and one-half terms to a maximum of 68 credit hours.

Curricula meeting all these requirements are not difficult to arrange and considerable latitude may be allowed to satisfy individual needs and inclinations. To assist students in planning their work, a number of suggestive curricula are on file in the office of the dean, School of Engineering.

The courses in engineering require that students *be strong in mathematics and physics, and have the scientific spirit. Those who are not qualified in these lines are advised not to undertake work in engineering.*

For a full statement of the requirements for entrance, see the annual catalog of the University. This may be obtained by addressing the Registrar, University of Missouri, Columbia, Missouri. For special information not found in the catalog, address the Dean of the Faculty of Engineering, University of Missouri, Columbia, Mo.

AGRICULTURAL ENGINEERING

(*Administered jointly by the Dean of the Faculty of Agriculture and the Dean of the Faculty of Engineering.*)

The demand for men trained in engineering as applied to different phases of agriculture has led to the introduction of a curriculum in agricultural engineering. This curriculum emphasizes the fundamentals of engineering subjects, makes the student familiar with modern scientific agriculture and gives him a training in agricultural engineering.

The training contemplated will fit men for professional work in that line of engineering where an agricultural viewpoint is necessary, such as problems in drainage and irrigation, planning for buildings, and design of farm machinery. It will fit men for government and teaching positions, to be experts and salesmen with farm machinery manufacturers, and will prepare them to take charge of large farms where engineering applications in agriculture are important factors.

CHEMICAL ENGINEERING

The rapid devolpment of the chemical industries and the ever increasing demand for engineers trained in the fundamental subjects have led to the introduction of courses in chemical engineering. The curriculum outlined is designed to give a broad and thoro training in general engineering subjects and in theoretical and applied chemistry. Instruction in chemistry continues thru the whole length of the curriculum. The general principles of physical science are further emphasized by extended courses in mathematics, physics, and mechanics.

The curriculum aims to implant in the students a scientific method of work. Instruction is given by means of recitations, lectures, laboratory work, and conferences. The electives enable the student to give some attention to specialization, but the prime object is to produce a broadly trained chemical engineer.

CIVIL ENGINEERING

The field covered by this curriculum is wide, embracing topographical, railway, hydraulic, structural, municipal, and highway engineering. It is the aim to give a broad general training which may later serve as a foundation for the development of any special line under the general term, civil engineering.

The curriculum has, therefore, been arranged with the purpose of providing thoro training in those fundamental sciences and principles upon which the practice of the civil engineer is based, and also, in so far as practicable of giving instruction in the special subjects which underlie the several branches. A number of subjects are made elective, with the object of permitting the student to select his more advanced work in one of the special divisions of civil engineering.

ELECTRICAL ENGINEERING

The curriculum in electrical engineering is intended to prepare students for electrical designing, manufacturing, contracting, and for the installation and management of central and isolated electric light stations, power plants, and electric railways. It is planned to furnish insight into and appreciation of the complex problems requiring solution by electrical engineers, while giving thoro, broad training.

The technical work consists of the theory and principles of electricity and magnetism; electrical measurements; calibration of instruments; tests of all kinds; designs and construction; study of problems in the generation, transmission, distribution, and utilization of electrical energy.

Special attention is paid to alternating current phenomena.

MECHANICAL ENGINEERING

The curriculum in mechanical engineering is intended to fit young men to get the greatest advantage from the practical experience which must precede, accompany or follow such a study of the applications of the sciences in a profession; and to enable them to be of earlier and greater responsible value in connection with engineering properties—as designers, installing engineers, in testing and inspection work in engineering salesmanship or other associated specialties, in power plant operation, in manufacturing, in efficiency improvement, and in the conception, organizing, and direction of extended mechanical industrial enterprises.

CURRICULA IN ENGINEERING 1921-22

First year (same in all curricula.)

Subject.	Department and Course No.	Fall	Term. Winter	Spring Half.
Problems in citizenship, including English composition	Citizenship 1f, 2w	5	5	
Trigonometry and algebra	Math. 2f	5		
Analytic geometry	Math. 4w		5	
Calculus	Math. 5sp			3
General inorganic chemistry	Chem. 1f or w	5 or 0	0 or 5	
Drawing I	E. D. 1f or w	0 or 3	3 or 0	
Woodwork	I. A. 1f or w	0 or 2	2 or 0	
Elementary surveying	C. E. 102sp			3 or
Materials of construction	C. E. 132sp			0 or
Drawing II	E. D. 2sp			2 or
Metalwork	I. A. 2sp			0 or
Military science and physical education	M. S.	2	2	
		17	17	8

Agricultural Engineering
SECOND YEAR

Subject.	Department and Course No.	Term. Fall.	Winter.
Calculus	Math. 6f, 7w	3	3
General physics	Physics 3f, 4w	5	5
Elementary surveying	C. E. 102f	3 or 0	
Materials of construction	C. E. 132f	0 or 3	
Mechanics of engineering	Mech. 100w		3
Drawing II	E. D. 2f	2 or 0	
Metalwork	I. A. 2f	0 or 2	
Analytical chemistry	Chem. 25w		5
Roads and pavements	C. E. 151f	2	
Military science and physical education	M. S.	2	2
		17	18

Agricultural Engineering
THIRD YEAR

Mechanics of engineering	Mech. 101f	5	
Electrical machinery	E. E. 101f, 102w	4	4
Farm machinery	Ag. E. 30w		2
Farm gas engines	Ag. E. 11w		2
Field crops	F. C. 1f	5	
Farm shop practice	Ag. E. 10f	2	
Soil physics	Soils 1w		5
Technical writing	English		2
		16	15

Agricultural Engineering

FOURTH YEAR

Subject.	Department and Course No.	Term.	
		Fall.	Winter.
Hydraulics	C. E. 140f	3	
Heat machinery A	M. E. 131w		3
Farm tractors	Ag. E. 112f	2	
General economics	Econ. 1w		5
Types and classes of live stock	A. H. 1f	3	
Farm buildings	Ag. E. 3f	4	
Farmstead equipment	Ag. E. 40w		3
Irrigation and drainage	C. E. 243f	2	
Elective			3
		14	14

Chemical Engineering

SECOND YEAR

Calculus	Math. 6f, 7w	3	3
General physics	Physics 3f, 4w	5	5
Elementary surveying	C. E. 102f	3 or 0	
Materials of construction	C. E. 132f	0 or 3	
Mechanics of engineering	Mech. 100w		3
Drawing II	E. D. 2f	2 or 0	
Metalwork	I. A. 2f	0 or 2	
Qualitative analysis	Chem. 27w		3
Inorganic chemistry	Chem. 2f	3	
Military science and physical education	M. S.	2	2
		18	16

THIRD YEAR

Mechanics of engineering	Mech. 101f	5	
Electrical machinery	E. E. 101f, 102w	4	4
Quantitative chemical analysis	Chem. 121f	5	
Organic chemistry	Chem. 110w		5
Graphic statics	C. E. 120w		2
Technical writing	English		2
Elective			3
		14	16

FOURTH YEAR

Hydraulics	C. E. 140f	3	
General economics	Econ. 1w		5
Physical chemistry	Chem. 131f	5	
Machine design A	M. E. 103f	4	
Heat machinery A	M. E. 131f		3
Elective		3	7
		15	15

Civil Engineering

SECOND YEAR

Subject.	Department and Course No.	Term. Fall.	Term. Winter.
Calculus	Math. 6f, 7w	3	3
General physics	Physics 3f, 4w	5	5
Elementary surveying	C. E. 102f	3 or 0	
Materials of construction	C. E. 132f	0 or 3	
Mechanics of engineering	Mech. 100w		3
Drawing II	E. D. 2f	2 or 0	
Metalwork	I. A. 2f	0 or 2	
Higher surveying	C. E. 104w		4
Roads and pavements	C. E. 151f	2	
Military science and physical education	M. S.	2	2
		17	17

THIRD YEAR

Mechanics of engineering	Mech. 101f	5	
Electrical machinery	E. E. 101f, 102w	4	4
Hydraulics	C. E. 140w		3
Graphic statics	C. E. 120f	2	
Stresses	C. E. 121w		3
Heat machinery A	M. E. 131f	3	
General economics	Econ. 1w		5
		14	15

FOURTH YEAR

Railway surveying	C. E. 111f	4	
Sanitary engineering	C. E. 152f	2	
Masonry structures	C. E. 125w		3
Physical geology	Geology 2w		3
Machine design A	M. E. 103f	4	
Technical writing	English		2
Structural design	C. E. 122w	3	
Elective		3	7
		16	15

Electrical Engineering

SECOND YEAR

Calculus	Math. 6f, 7w	3	3
General physics	Physics 3f, 4w	5	5
Elementary surveying	C. E. 102f	3 or 0	
Materials of construction	C. E. 132f	0 or 3	
Mechanics of engineering	Mech. 100w		3
Drawing II	E. D. 2f	2 or 0	
Metalwork	I. A. 2f	0 or 2	
General economics	Econ. 1w		5
Elective		2	
Military science and physical education	M. S.	2	2
		17	18

Electrical Engineering

THIRD YEAR

Subject.	Department and Course No.	Term. Fall.	Term. Winter.
Mechanics of engineering	Mech. 101f	5	
Electrical machinery	E. E. 101f, 102w	4	4
Advanced calculus	Math.		3
Hydraulics	C. E. 140f	3	
Heat machinery A	M. E. 131f	3	
Graphic statics	C. E. 120f		2
Machine design A	M. E. 103f		4
Technical writing	English		2
		15	15

FOURTH YEAR

Subject.	Department and Course No.	Term. Fall.	Term. Winter.
Advanced D. C. machinery	E. E. 103f	3	
Advanced A. C.	E. E. 110f	3	
Advanced A. C. machinery	E. E. 111w		6
Telephony	E. E. 134w		2
Heat machinery B	M. E. 132f	4	
Elective		5	6
		15	14

Mechanical Engineering

SECOND YEAR

Subject.	Department and Course No.	Term. Fall.	Term. Winter.
Calculus	Math. 6f, 7w	3	3
General physics	Physics 3f, 4w	5	5
Elementary surveying	C. E. 102f	3 or 0	
Materials of construction	C. E. 132f	0 or 3	
Mechanics of engineering	Mech. 100w		3
Drawing II	E. D. 2f	2 or 0	
Metalwork	I. A. 2f	0 or 2	
Machine work	I. A. 4w		4
Pattern making	I. A. 3w	2	
Military science and physical education	M. S.	2	2
		17	17

THIRD YEAR

Subject.	Department and Course No.	Term. Fall.	Term. Winter.
Mechanics of engineering	Mech. 101f	5	
Electrical machinery	E. E. 101f, 102w	4	4
Advanced calculus	Math.		3
General economics	Econ. 1f	5	
Graphic statics	C. E. 120f	2	
Technical writing	English		2
Heat machinery A	M. E. 131w		3
Machine design A	M. E. 101w		4
		16	16

Mechanical Engineering
FOURTH YEAR

Subject.	Department and Course No.	Term. Fall.	Term. Winter.
Hydraulics	C. E. 140f	3	
Machine design B	M. E. 103w		3
Mechanical laboratory A	M. E. 121f, 122w	2	2
Heat machinery B	M. E. 132f, 133w	4	3
Elective		5	6
		14	14

Note: Applicants for the Bachelor's degree must submit evidence of two months' experience in some field of engineering or activity closely related to engineering.

AGRICULTURAL ENGINEERING

Required Work:

			Hours
C. E.	291w.	Specification and contracts	1
"	142w.	Water supply	2
Hort.	110f.	Landscape design	2
R. L.	110w.	Farm organization	3
A. E.	122w.	Irrigation and drainage	2
"	200f.	or w. Thesis	3
			13

At least 8 hours to be selected from the following group:

C. E.	120f.	Graphic statics	2
"	125w.	Masonry structures	3
E. E.	121w.	Electric motors	3
E. D.	2f.	Drawing II	2
M. E.	151f.	Heating and ventilation	3
"	154f.	Refrigeration	3
"	101w.	Machine design A	3
Hort.	112w.	Spraying	2
F. C.	3f.	Field crop management	2
			23

CHEMICAL ENGINEERING

Required Work:

C. E.	291w.	Specifications and contracts	1
Chem.	141f.	Industrial chemistry	3
"	122f.	Quantitative chemical analysis	5
"		Thesis	3
			12

At least 8 hours to be selected from the following group:

Chem.	125w.	Quantitative organic analysis	6
"	133w.	Electro chemistry	5
"	142w.	Industrial chemistry	3
"	211f.	Advanced organic chemistry	5 to 6
"	227w.	Advanced analytical chemistry	2 to 5
Physics	104f.	Electrical measurements	4
Geol.	106f.	Mineralogy	5
Botany	3f.	General bacteriology	3
		Total	33 to 37

CIVIL ENGINEERING

Required Work:

C. E.	112f.	Railway location and construction	2
"	113w.	Economics of railway construction	2
"	222f.	Bridge design	3
"	133w.	Testing laboratory	1
"	141f.	Water power	3
"	291w.	Specifications and contracts	1
			12

At least 8 hours to be selected from one of the following groups:

1.—Railway and Structural.

C. E.	214w.	Railway engineering	3
"	215w.	Railway yards and terminals	2
E. E.	241w.	Electric railway engineering	2
C. E.	223w.	Higher structures	3
"	226f.	Concrete structures	3
"	201w.	Geodetic surveying	3
			16

II.—Hydraulic and Geological.

C. E.	142w.	Water supply	2
"	243w.	Irrigation and drainage	2
"	244w.	Rivers and canals	2
"	201w.	Geodetic surveying	3
"	226f.	Concrete structures	3
Geol.	108w.	Rocks and rock minerals	3
"	100f.	Economic geology	3
			18

III.—Municipal and Highway.

C. E.	157w.	Sanitary design	2
Botany	3f.	General bacteriology	3
C. E.	142w.	Water supply	2
"	106f.	City planning	2
"	134w.	Road materials	3
"	110w.	Highway engineering	2
"	256f.	Highway design	2
			16

ELECTRICAL ENGINEERING

Required Work:

E. E.	220f.	Electrical machine design	3
"	230f.	or w. Generation and distribution	3
Physics	104f.	Electrical measurements	4
C. E.	291w.	Specifications and contracts	1
E. E.	298f. 299w.	Thesis	3
			14

At least 8 hours to be selected from the following groups:

I.—Power Group.

E. E.	242w.	Transmission	3
"	240w.	Central station design	2
C. E.	141f.	Water power	3
M. E.	133w.	Heat machinery B	3
"	131f. 122w.	Mechanical laboratory A	4
"	234f. 235w.	Gas engineering	4
			19

II.—Design Group.

E. E.	244w.	Analysis of design problems	2
M. E.	103w.	Machine design, B	3
E. E.	240w.	Central station design	2
"	250f.	Special electrical laboratory	2
"	280w.	Application of mathematics to E. E.	2
C. E.	124w.	Mill structures	2
			13

MECHANICAL ENGINEERING

Required Work:

C. E.	291w.	Specifications and contracts	1
M. E.	111f.	Management engineering	3
"	151f.	Heating and ventilation	3
"	234f. 235w.	Gas engineering	4
			11

At least 8 hours to be selected from one of the following groups:

I.—Power Group.

C. E.	141f.	Water power	3
M. E.	134f.	Steam power plants	4
"	135f.	Steam turbines	2
"	231w.	Applied thermodynamics	3
"	154f.	Refrigeration, A	3
"	251w.	Railway mechanical engineering (locomotive)	2
			17

II.—Design and Manufacturing Group.

E. E.	131w.	Electric motors	2
”	133f.	Illumination	2
C. E.	133w.	Testing laboratory	1
M. E.	102f.	Technology of metals	2
”	104f.	Machine design	2
”	172w.	Engineering charts	1
”	211w.	Shopwork engineering	2
”	262w.	Railway mechanical engineering (design)	2
			14

Note:—Students electing any one of the above groups, who are interested in the principles of business or public administration, or in the field of pure science, may elect, with the approval of the adviser, work in the School of Business and Public Administration, or in the departments of mathematics and physics.

Applicants for the professional degrees must submit evidence of four months' experience in some field of engineering or activity closely related to engineering.

STATEMENT OF COURSES

Courses designated by a number with the letter f attached, thus: 100f, are given the fall term only. Those designated by a number with the letter w attached, thus: 100w, are given the winter term only.

Those designated by a number with the letters sp attached are given during the first eight weeks of the spring-summer term only, and those marked sm are given for the last eight weeks of the spring-summer term.

Courses numbered 200 and above are strictly graduate in character. *Arabic numerals in parenthesis indicate the number of hours credit a term.* A full description of courses will be found in the annual catalog, which may be obtained by addressing the Registrar, University of Missouri, Columbia, Missouri.

AGRICULTURAL ENGINEERING

1f. Agricultural Drawing (2) — Mr. Wooley.
2f. Farm Construction Methods (2) — Mr. Wooley.
3f. Farm Buildings (2 or 4) — Mr. Wooley.
10f. Farm Shop Practice (2) — Mr. Jones.
11f. Farm Gas Engines (2) — Mr. Jones.
20f. Farm Surveying (2) — Mr. Wooley.
21w. Farm Drainage (2) — Mr. Wooley.
30w. Farm Machinery (2) — Mr. Jones.
40w. and sm. Farmstead Equipment (2) — Mr. Wooley.
112f and sp. Farm Tractors (2) — Mr. Jones.
122w. Irrigation and Drainage (2) — Mr. Wooley.

CHEMICAL ENGINEERING

Courses in this department not strictly engineering may be found in the general catalog under the department of chemistry.

CIVIL ENGINEERING

Topographical Engineering

102f, w, and sp. Elementary Surveying (3) — Mr. Williams, Mr. Miller.

104w. Higher Surveying (4) — Mr. Williams.
106f. City Planning (2) — Mr. Williams.
201w. Geodetic Surveying (3) — Mr. Williams.

Railway Engineering

111f. Railway Surveying (4) — Mr. Miller.
112f. Railway Location and Construction (2) — Mr. Miller.
113w. Economics of Railway Construction (2) — Mr. Miller.
214w. Railway Engineering (3) — Mr. Miller.
215w. Railway Yards and Terminals (2) — Mr. Miller.

Structural Engineering

120f and w. Graphic Statics (2) — Mr. Hyde.
121f. Stresses (3) — Mr. Hyde.
122w. Structural Design (3) — Mr. Hyde.
124w. Mill Structures (2) — Mr. Hyde.
222w. Bridge Design (3) — Mr. Hyde.
223w. Higher Structures (3) — Mr. Hyde.
226f. Concrete Structures (3) — Mr. Spalding.
227f or w. Theory of Structures — Mr. Hyde.

Materials of Construction

132f. Materials of Construction (3) — Mr. LaRue, Mr. Spalding.
133w. Testing Laboratory (1) — Mr. LaRue.
134w. Road Material (3) — Mr. LaRue.
231f or w. Experimental Investigation.

Hydraulic Engineering

140f or w. Hydraulics (3) — Mr. Rodhouse.
141f. Water Power (3) — Mr. Rodhouse.
142w. Water Supply (2) — Mr. Rodhouse.
243f. Irrigation and Drainage (2) — Mr. Rodhouse.

Municipal Engineering

151f. Roads and Pavements (2) — Mr. Spalding.
152f. Sanitary Engineering (2) — Mr. McCaustland.

155w. HIGHWAY ENGINEERING (2) — Mr. Spalding.
157w. SANITARY DESIGN (2) — Mr. McCaustland.
256f. HIGHWAY DESIGN (2) — Mr. Spalding.
257f or w. SANITARY ENGINEERING — Mr. McCaustland.

General

291w. SPECIFICATIONS AND CONTRACTS (1) — Mr. Spalding.
299w. THESIS (1) fall term; (2) winter term.

ENGINEERING DRAWING

1f or w or sp. DRAWING I (3) — Mr. Newton.
2f or w or sp. DRAWING II (2) — Mr. Newton, Mr. Miller.

ELECTRICAL ENGINEERING

101f, 102w. ELECTRICAL MACHINERY (4) — Mr. Wienbach, Mr. Miller.

103f. ADVANCED DIRECT CURRENT MACHINERY (3) — Mr. Lanier, Mr. Miller.

110f. ADVANCED ALTERNATING CURRENTS (3) — Mr. Wienbach, Mr. Miller.

111w. ADVANCED A. C. MACHINERY (4) — Mr. Lanier, Mr. Miller.
131w. ELECTRIC MOTORS (2) — Mr. Wienbach.
132f. STORAGE BATTERY ENGINEERING (2) — Mr. Wienbach.
133f. ILLUMINATION (2) — Mr. Miller.
134w. TELEPHONY (2) — Mr. Wienbach.
143w. ELECTRICAL PROCESSES (2) — Mr. Wienbach.
220f. ELECTRICAL MACHINE DESIGN (3) — Mr. Lanier.
230f. GENERATION AND DISTRIBUTION (3) — Mr. Wienbach.
240w. CENTRAL STATION DESIGN (2) — Mr. Miller.
241w. ELECTRIC RAILWAY ENGINEERING (2) — Mr. Miller.
242w. TRANSMISSION (3) — Mr. Wienbach.
244w. ANALYSIS OF DESIGN PROBLEMS (2) — Mr. Lanier.
250f. SPECIAL ELECTRICAL LABORATORY (2) — Mr. Lanier.
280w. APPLICATION OF MATHEMATICS TO ELECTRICAL ENGINEERING (2) — Mr. Weinbach.
290. RESEARCH.
298f, 299w. THESIS (1) fall term; (2) winter term.

INDUSTRIAL ARTS

1f and w. WOODWORK (2) — Mr. Pearson.
2f. and w. METAL WORK (2) — Mr. Allton.
3f and w. PATTERN MAKING (2) — Mr. Selvidge.

4f and w. MACHINE WORK (4) — Mr. Jaeger.

5f. TOOLS AND MATERIAL (1) — Mr. Selvidge.

133w. ADVANCED MOLDING AND FOUNDRY PRACTICE (3) — Mr. Allton.

134f. ADVANCED PATTERN MAKING (3) — Mr. Selvidge.

135f. ADVANCED FORGE WORK (3) — Mr. Allton.

136f or w. ADVANCED MACHINE WORK (3) — Mr. Jaeger.

MECHANICAL ENGINEERING

Design

101f and w. MACHINE DESIGN, A (4) — Mr. Newton.

102f. TECHNOLOGY OF METALS (2) — Mr. Hibbard.

103w. MACHINE DESIGN, B (3) — Mr. Newton.

104f. MACHINE DESIGN, C (2) — Mr. Newton.

201f and w. SPECIAL MACHINE DESIGN.

Industrial Engineering

111f and w. MANAGEMENT ENGINEERING (3) — Mr. Hibbard.

211w. SHOPWORK ENGINEERING (2) — Mr. Hibbard.

Testing and Experimental Engineering

121f, 122w. MECHANICAL LABORATORY, A (2) — Mr. Wharton.

123f. MECHANICAL LABORATORY, B (2) — Mr. Wharton.

221f or w. SPECIAL MECHANICAL LABORATORY.

Power Engineering

131f and w. HEAT MACHINERY, A (3) — Mr. Hibbard.

132f, 133w. HEAT MACHINERY, B (3) — Mr. Wharton.

134f. STEAM POWER PLANTS (4) — Mr. Hibbard.

135f. STEAM TURBINES (2) — Mr. Newton.

231w. APPLIED THERMODYNAMICS (3) — Mr. Wharton.

234f and w. GAS ENGINEERING (2) — Mr. Newton.

Power Applications

151f. HEATING AND VENTILATION (3) — Mr. Newton.

154f. REFRIGERATION, A (3) — Mr. Wharton.

251w. REFRIGERATION, B — Mr. Wharton.

261f and 262w. RAILWAY MECHANICAL ENGINEERING (2) — Mr. Hibbard.

The student may elect work in this course along the lines of railway shops, car design, locomotive design, or locomotive operation.

General

171w. SEMINARY (1) — Mr. Hibbard.

MECHANICS

100w. MECHANICS OF ENGINEERING (3) — Mr. Defoe.
101f. MECHANICS OF ENGINEERING (5) — Mr. Defoe.
112f and w. ADVANCED MECHANICS (3) — Mr. Defoe.
205f and w. ELASTICITY (3) — Mr. Defoe.

OTHER COURSES

The following courses offered in the College of Arts and Science are of particular interest to students in the School of Engineering:

ASTRONOMY. 1f or w, *Descriptive Astronomy;* 103f, *Geodetic Astronomy.*

ECONOMICS. 1f or w, *General Economics;* 106f or w, *Problems of Labor;* 117f or w, *Accounting;* 233f or w, *Valuation of Public Utilities.*

GEOLOGY. 1f or w, *Physical Geology;* 4w, *Rocks and Minerals;* 100f, *Economic Geology;* 107f, *Field Geology.*

MATHEMATICS. 120f and w, *Differential Equations and their applications.*

PHYSICS. 104f, *Electrical Measurements;* 110w, *Electricity, and Magnetism;* 207, *Theory of Electricity and Magnetism;* 112f, *Heat;* 206, *Theory of Heat;* 221w, *Electrical Waves.*

GRADUATE WORK IN ENGINEERING

Graduates of the School of Engineering holding professional degrees (C. E., M. E., E. E., Ch. E.) will be admitted to candidacy for the degree of Doctor of Philosophy (Ph. D.) in the Graduate School upon the completion of a minimum of four terms of additional work.

Graduates of other schools of engineering in good standing who have completed five years of university work will be admitted on the same basis. A minimum of six terms of graduate work will be required of all graduates of engineering schools who have completed only eight terms of university work.

The faculty of the Graduate School reserves the right to pass on the qualifications of all candidates.

The graduate student is expected to devote the greater part of his time to research work. A part of the time may be given to some of the advanced courses in engineering, or other university courses allied to the main subject of study.

The work of each candidate is under the supervision of a special committee of the faculty, whose function is to advise the student in regard to his course of study and the subject of his research.

The usual work consists of the investigation of some engineering problem of practical or scientific importance. In this the student is thrown largely upon his own resources, and must show originality and capability of accurate scientific thinking. The results of the researches are to be embodied in a dissertion which shall give evidence of the merit of the work and the ability of the student. The regulations governing the degree of Doctor of Philosophy are given in the annual catalog.

The equipment and funds of the Engineering Experiment Station are available for experimental research, provided the subjects being investigated are of such practical importance as to conform to the general purpose for which the experiment station was established.

A limited number of research assistants in the Engineering Experiment Station are appointed each year, and, under suitable conditions, work carried on by these assistants may count toward the Doctor's degree. This makes the research assistantship equivalent to a graduate fellowship, enabling the candidate thus appointed to work toward his degree and at the same time earn his expenses during a part of the time.

For further information regarding graduate work, address DEAN OF THE GRADUATE FACULTY, UNIVERSITY OF MISSOURI, COLUMBIA, MISSOURI.

OFFICERS OF INSTRUCTION AND ADMINISTRATION

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THE ENGINEERING EXPERIMENT STATION

Officers of the Station

ALBERT ROSS HILL, A. B., Ph. D., LL. D., President of the University.

ELMER JAMES McCAUSTLAND, C. E., M. C. E., Dean of the Faculty of Engineering, Director of the Engineering Experiment Station.

The Engineering Experiment Station of the University of Missouri was established by order of the Board of Curators, July 1, 1909.

The object of the station is to be of service to the people of the State of Missouri:

First, by investigating such problems in engineering lines as appear to be of the most direct and immediate benefit and publishing these studies and information in the form of bulletins.

Second, by research of importance to the manufacturing and industrial interests of the state and to engineers.

The staff of the station consists at present of a director and four research assistants together with a number of teachers who have undertaken research under the direction of the station.

Suggestions as to problems to be investigated, and inquiries will be welcomed.

Bulletins have been published as follows:

Vol. 1, No. 1 *Acetylene for Lighting Country Homes,* by J. D. Bowles, research assistant, 1909-10.

Vol. 1, No. 2, *Water Supply for Country Homes,* by K. A. McVey, research assistant, 1909-10.

Vol. 1, No. 3, *Sanitation and Sewage Disposal for Country Homes,* by W. C. Davidson.

Vol. 2, No. 1 *The Heating Value and Proximate Analysis of Missouri Coals,* by C. W. Marx and Paul Schweitzer. (a reprint.)

Vol. 2, No. 2, *Friction and Lubrication Testing Apparatus,* by Alan E. Flowers.

Vol. 2, No. 3, *Tests of Road Materials of Missouri,* by W. S. Williams and Warren Roberts.

Vol. 3, No. 1, *The Use of Metal Conductors to Protect Buildings From Lightning,* by E. W. Kellogg.

Vol. 3, No. 2, *Firing Tests on Missouri Coal,* by H. N. Sharp, research assistant, 1911-12.

Vol. 3, No. 3, *A Report on Steam Boiler Trials Under Operating Conditions,* by A. L. Westcott.

Vol. 4, No. 1, *Economics of Rural Distribution of Electric Power,* by L. E. Hildebrand, research assistant, 1912-13.

Vol. 4, No. 2, *Comparative Tests of Cylinder Oils,* by M. P. Weinbach.

Vol. 4, No. 3, *Artesian Waters of Missouri,* by A. W. McCoy, research assistant, 1912-13.

Vol. 4, No. 4, *Friction Tests of Lubricating Grease and Oils,* by A. L. Westcott.

Engineering Experiment Station Series 14, *A Study of the Effect of Heat on Missouri Granites,* by W. A. Tarr and L. M. Neuman, research assistant, 1913-14.

Engineering Experiment Station Series 15, *A Preliminary Study Relating to the Water Resources of Missouri,* by T. J. Rodhouse. (Out of print.)

Engineering Experiment Station Series 16, *The Economics of Electric Cooking,* by P. W. Gumaer.

Engineering Experiment Station Series 17, *Earth Roads and the Oiling of Roads,* by H. A. LaRue.

Engineering Experiment Station Series 18, *Heat Transmission Thru Boiler Tubes,* by E. A. Fessenden and J. W. Haney, research assistant, 1915-16.

Engineering Experiment Station Series 19, *Geology of Missouri,* by E. B. Branson.

Engineering Experiment Station Series 20, *Energy Necessary to Shear Steel at High Temperatures,* by Guy D. Newton.

Engineering Experiment Station Series 21, *Water Supply and Sewage Disposal for Country Homes,* by E. J. McCaustland.

Engineering Experiment Station Series 22, *Study Relating to the Water Resources of Missouri,* by T. J. Rodhouse.

The following studies are now in progress: Coal testing, Investigation of Asphaltic sandstones of Missouri, Insulating value of paints and varnishes, Water resources of Missouri, Artificial illumination, Missouri clays, Water power in Missouri, Metallic alloys, Available road materials in Missouri. Besides these a number of detailed studies of materials and processes and investigations of Missouri's resources are in progress.

A standardizing laboratory has been established and the apparatus is now available for tests of electric, gas, and water meters of practically all types.

The State Highway Department is making use of the laboratories of the Engineering Experiment Station for the testing of road materials used in the state.

Any resident of the state may, on request, obtain the bulletins as issued. Those who are particularly interested may have their names placed on the regular mailing list. Address DIRECTOR, ENGINEERING EXPERIMENT STATION, UNIVERSITY OF MISSOURI, COLUMBIA, MISSOURI.

For further information concerning the School of Engineering, address E. J. McCAUSTLAND, DEAN, FACULTY OF ENGINEERING, UNIVERSITY OF MISSOURI, COLUMBIA, MISSOURI.

The general University catalog or special bulletins of any department will be sent upon request to THE REGISTRAR, UNIVERSITY OF MISSOURI, COLUMBIA, MISSOURI.

INFORMATION ABOUT THE UNIVERSITY

The fundamental aim of the University of Missouri is the development of the highest and most efficient type of citizen. For the purpose of accomplishing its aim, the University furnishes ample facilities for liberal education and for thoro professional training. The University is a part of the public educational system of the state.

The work of the University is now carried on in the following divisions: College of Arts and Science, College of Agriculture, School of Education, School of Law, School of Medicine, School of Engineering, School of Mines and Metallurgy, School of Journalism, School of Business and Public Administration, Graduate School, Extension Division.

All of these divisions are at Columbia, with the exception of the School of Mines and Metallurgy, which is at Rolla. In addition, emphasis is given particular lines of work by the establishment of minor divisions, the chief of which are the Agricultural Experiment Station, the Engineering Experiment Station, and the Missouri State Military School.

The University of Missouri is at Columbia, half way between St. Louis and Kansas City, near the center of the state. It is reached by the Wabash and by the Missouri, Kansas, & Texas railways. Columbia is a progressive and prosperous city.

The University grounds cover more than 800 acres. The main divisions are in the Francis Quadrangle, the east campus, the athletic fields, and the University farm. About forty University buildings are at Columbia.

THE
UNIVERSITY OF MISSOURI
BULLETIN

GENERAL SERIES

EDITED BY
CHARLES E. KANE
University Publisher

The General Series of the University of Missouri Bulletin consists of the University Catalog and the announcements of the various colleges and schools which make up the University. These announcements will be sent free upon request to the Registrar, University of Missouri, Columbia, Missouri.

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